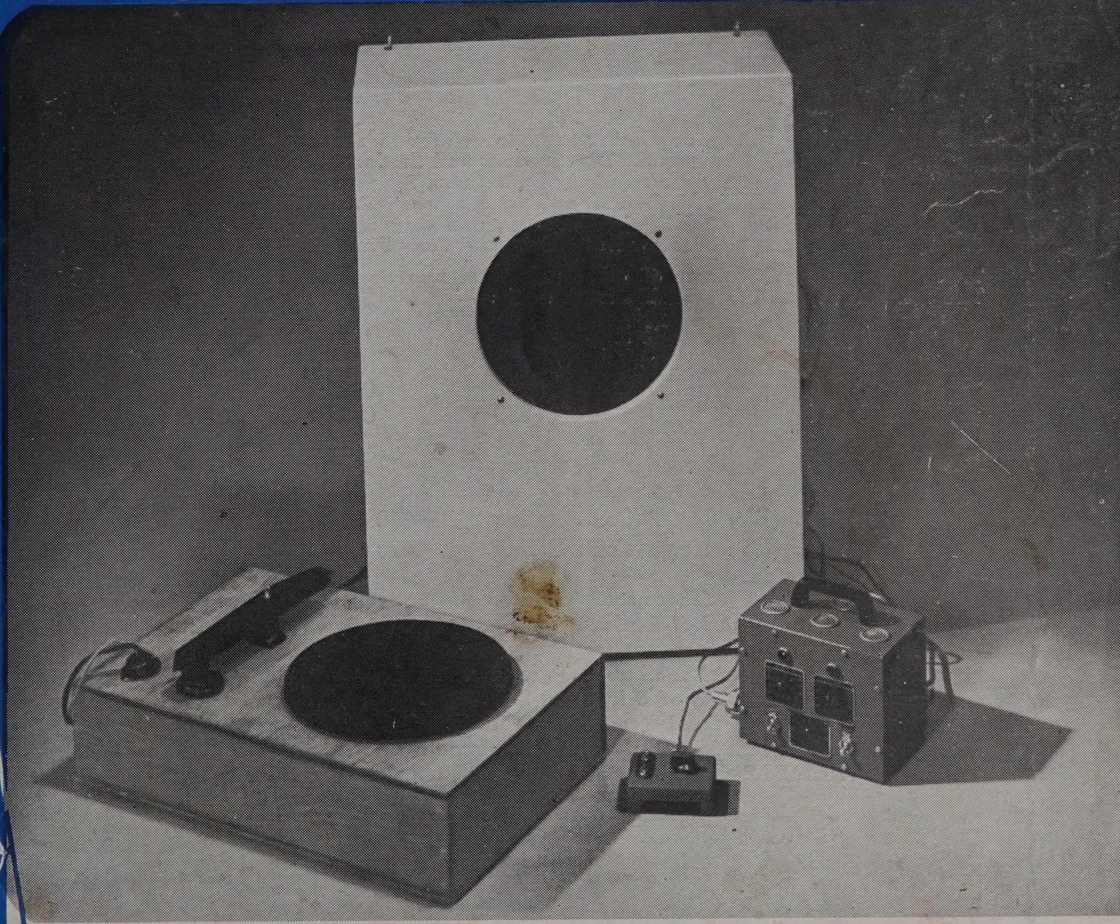
RADIO and ELECTRONICS

ELECTRICITY — COMMUNICATIONS — SERVICE — SOUND



JANUARY 1st, 1950 VOL. 4, NO. 11

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BRITISH-MADE VARIABLE
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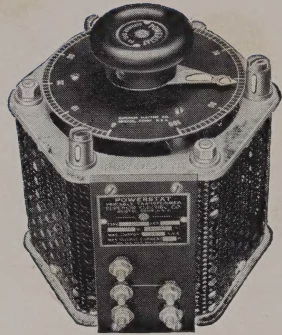

POWERSTATS

Infinitely-variable voltage-regulating auto-transformers are most useful devices, and they are largely employed by Government Departments and the leading power companies, being of special interest to the latter. They are regularly built in as integral control equipment, in particular in Meter-testing Assemblies, Laboratory Test-apparatus, Radio Transmission Equipment, X-Ray Equipment, Furnace-control Equipment, etc., and they are also nowadays being employed quite largely as Stage, etc., "Dimmers" in theatres and for "Photoflood" control in studios.

There are literally hundreds of other uses, and new applications are emerging continuously. The following types are available from stock:—

Type	Max. Rating (V.A.)	Input Volts	Output V.(Max.)	Output Rated	Current Max.
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100-RM	2000	230	0–270	8.	9.

STATIC TRANSFORMERS FOR "VOLTAGE-BOOSTING" CIRCUITS

Type CL (BT) No. 2 Cont. Rating ...... 450VA 200–50V. at 25 amps.
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SPECIAL NOTICE: **These static transformers are exceptionally useful for the restoration of low-line voltage to normal. When used with the types 50-B, 100-R, and 200-CUH "Variac" transformers, on lines which are not more than about 50 volts "low," they not only provide a "boost" to normal line voltage but also give a manual setting, variable from 200-250 volts, at any loading to a maximum of 8 kw. and 2.3 kw., respectively, despite the fact that these two Transformers are only rated (continuous) at 2.2 kw. and 580 va. respectively. (This is on account of the fact that in our circuit we are employing these Transformers in terms of the amount of VARIABLE power they are being called upon to handle.)**

Swan Electric Co. Ltd.

AUCKLAND · WELLINGTON · CHRISTCHURCH · DUNEDIN

RADIO and ELECTRONICS

Vol. 4, No. 11 January 1st, 1950

OUR COVER

This month's cover illustrates the portable gramophone outfit to be described in next month's issue. The turntable unit, amplifier, and midget crystal tuner are all accommodated inside the speaker baffle-box for carrying, together with the various connecting cables. The small size of the amplifier can be gauged from the other things in the photograph.

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Sole Wholesale N.Z. Distributors FEATURE PRODUCTIONS LTD., P.O. Box 5065, Wellington.

Printed in New Zealand by H. H. Tombs, Ltd., Wingfield Street, Wellington.

A NEW RADIO FREQUENCY MEASURING DEVICE

Every so often it is given to someone to have a very bright idea, which at one stroke produces a considerable advance in a technique which was stagnant through having been developed to the limit of its capabilities. One such technique is that of measuring circuit constants at radio frequencies by bridge methods.

Bridges have long been recognized as our most powerful tool for the measurement of circuit constants at zero frequency (D.C.) and at low frequencies, so that it was natural, when high-frequency work became more important with the development of radio, that engineers should investigate the possibilities of bridge methods at high frequencies. The results were disappointing, and to this day the radio-frequency bridge is not a widely-used instrument because of its limited accuracy and because of the difficulty of operating it so as to make the most of its characteristics. Because of this, substitution and resonance methods have become the most popular way of measuring R.F. constants, backed up by indirect calculation, which is never very satisfactory.

The trouble about the R.F. bridge, of course, is that its elements must be non-reactive and that the effects of stray capacities must be eliminated if the answers are to be at all accurate. Even so, equipment which is to work at more than a few megacycles per second is highly specialized in design, and very costly. These are the reasons that have made the "Q-meter" so popular a device. Its name is somewhat deceptive, as it is probably of more use as a method of making substitution and resonance types of measurement than simply for measuring the Q of coils. In spite of its usefulness, the Q-meter has undoubted limitations, chief among them being that it is essentially a high-impedance circuit, in which the R..F resistance of a coil is measured, not directly, but in terms of the dynamic impedance of a circuit at resonance. Because of its high impedance, the Q-meter circuit requires exceedingly careful construction in order that excessive losses may be avoided. In addition, much arithmetic is needed in order to arrive at the R.F. series resistance of a coil, while finding the true R.F. resistance of a resistor with the Q-meter is a lengthy and rather inaccurate process.

Recently, however, H. W. Kline, of the General Electric Company, has managed by what can only be described as a "brainwave," to combine the versatility of the Q-meter with the stability of the bridge and has given us an instrument which will measure R.F. resistance directly. After all, the fundamental property of a coil is its R.F. resistance rather than its Q, so that the new instrument puts us in the happy position of being able to measure the most important quantity directly, and then to calculate Q once the inductance of the coil is known. This is the reverse, in procedure and awkwardness, of the old method of measuring Q in order to find the resistance. It means that many more of our R.F. measurements can be done directly, and with an accuracy which is very difficult to achieve at R.F. by bridge methods alone.

Briefly (and simply, for, like all good ideas, this one *is* simple), the method consists of tuning the coil, resistor, or other component to series resonance rather than to parallel resonance, and then measuring the remaining resistance on a bridge, which, to make matters more attractive still, is direct-reading!

This method has numerous advantages over both ordinary bridges and the Q-meter. The stability and accuracy of the bridge can be made high by reducing the arms' impedance to a low level. The difficulty of balancing a bridge at high frequencies is minimized because the method of measuring is to unbalance one arm and then to read the resulting voltage output on a high-impedance rectifier meter using a crystal rectifier. Thus, the bridge consists of four low-value resistors whose reactance does not matter much as long as it is small, constant, and identical for all four. Balance is not employed as a criterion of measurement at all, and exact balance is quite unimportant, especially when calibration is done experimentally. The bridge is fed by an oscillator, whose harmonic content is unimportant and which can have a wide frequency range, limited only by the upper useful limit of the bridge—and this is high, owing to its low impedance.

From the point of view of measuring coils, the instrument is excellent, since the series method of resonating it does not require that any losses need to be connected in parallel with it. Thus, the R.F. resistance should be much more accurately found than by any means of a Q-meter.

Unfortunately, it is not possible in an editorial to enlarge fully upon it, but suffice it to say that, unlike the Q-meter, an R.F. resistance meter of this sort should be well within the scope of the small radio laboratory to produce and use to very good advantage, which is by no means true of many R.F. instruments.

THE "RADEL" 1950 PORTABLE FIVE

The season for portables has come round again, and we have pleasure in presenting a very sensitive five-valve circuit which is adaptable to a commercially available cabinet and chassis. This set will give excellent performance in localities where signal strengths are not great.

INTRODUCTION

During the past few years, considerable advances have been made in the design of portable receivers, owing partly to the excellent series of miniature valves that has become standardized for use in this kind of set and partly to the availability of semi-miniature components such as gang condensers and I.F. transformers. All these have made possible the production of portables of reasonable size and weight, and also have given us the miniature, or personal portable, which was hardly a practical proposition before. As to the latter, their value to the user is partly a matter of novelty, as in practice they have certain disadvantages compared with the larger sets. In particular, the miniature portable is not very well suited to the needs of the home constructor, for a number of reasons.

These sets really need small components of all sorts if they are to be really small, and their construction must be so compact as to cause technical difficulties of no mean order. Such a set is a difficult design problem, and when it is realized that its cost is no less than that of a larger receiver—which is much more satisfactory in terms of power output and battery life—it is doubtful whether the very small set is worth while for the amateur. The situation is different for the manufacturer, who can afford to spend considerable time and trouble on initial design work because his quantity production makes it profitable. He is also in a better position as regards the close and compact work that is needed in constructing a miniature.

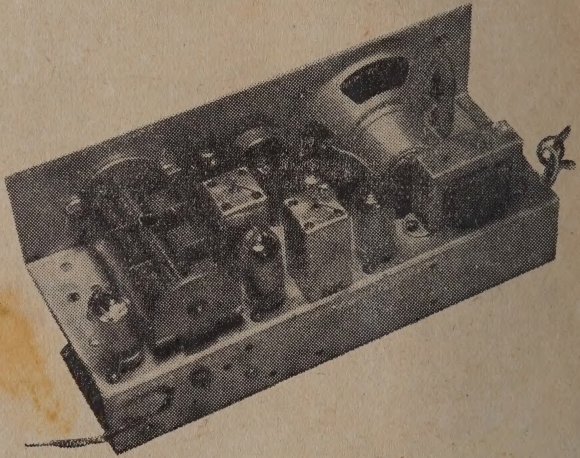
For these reasons, we have not yet attempted to produce a very small portable for amateurs to build. Constructors, we feel, would sooner see a greater return for their outlay by means of having a larger set with greater sensitivity and power output, and which does not use such expensive batteries. At the same time, a reasonably large cabinet enables batteries to be installed that do not need replacement every five minutes, as it were, especially when (as may happen during a good summer) the set is in use for a matter of several hours each day.

GENERAL DESCRIPTION

The set described in this article was purposely built to fit a cabinet of commercial design, which may be purchased from any dealer in parts. This saves a good deal of time and trouble for the constructor, who is not necessarily interested in providing his own cabinet or in achieving a "different" appearance. In addition, the same cabinet can be purchased complete with a metal chassis, specially designed for it, which is a further advantage. This is not to say that a different mechanical lay-out will not be suitable, for, as long as a sensible chassis arrangement is used, there is no good reason why the constructor should not use a chassis and cabinet of his own design, together with the circuit used in the original. The cabinet we refer to has a dial calibration screened on to the outside, so that the expense and size of a special dial movement are eliminated if the commercial cabinet is used.

In order to provide adequate sensitivity, a five-valve circuit has been used, and the design has been made quite generous in all respects. A fully-tuned stage of R.F. amplification and a large loop aerial, together with a new oscillator-mixer valve, make the sensitivity greater than most portables can show, with the result that, for pulling power, this little set will be found hard to beat. In Wellington, it is possible to bring in 3YA during the daytime at full volume and with so little set noise as to make it as useful as a local station. In the daytime, too, very readable results are obtained from 4YA, even in the centre of the noisy city area. At night, it is safe to say that all New Zealand stations can be received, and the stronger Australian stations come in with good strength and are quite listenable.

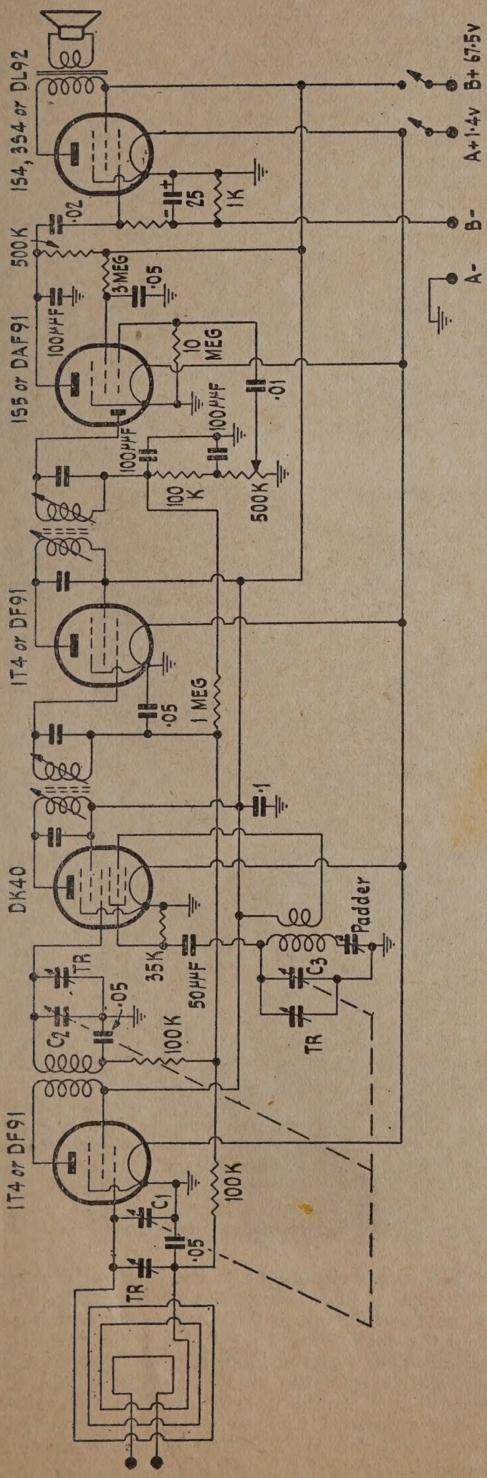
This performance, it may be said, is achieved without the slightest suspicion of "edginess" or regeneration, and is due to good, solid, stable sensitivity. At the same time, there are no special tricks about the circuit which is conventional and quite straightforward. At the same time, it is strictly modern and employs high-gain midget I.F. transformers, together with one of the new P.V.C.-insulated loop aerials, which have an excellent performance.



Back view of the chassis.

THE CIRCUIT

The tuned R.F. stage uses a 1T4, or its Continental equivalent, the DF91, which has identical basing and characteristics. The oscillator-mixer valve is the new DK40. This is a "rimlock" valve, and so is a trifle larger than the normal miniatures, but it makes up for this in its excellent performance and its ease of application. Is is an octode, and, unlike the 1R5 or its equivalent DK91, has a separate oscillator plate electrode. It therefore does not require a special circuit, and is used in exactly the same way as other oscillator-mixer valves. Moreover, its oscillator plate is designed to take 67.5 volts on it, so that we do not need even a dropping resistor and decoupling condenser in a set, like this one, which uses 67.5 volts for the H.T. to all valves. This tube has the further advantage of higher conversion gain than the miniature types mentioned above, and this contributes in



no small measure to the unusually high sensitivity of the set. A glance at the "front end" of the circuit shows how few small parts are needed when this valve is used, and this is always a consideration in helping to reduce cost and make construction easier.

The I.F. amplifier is another 1T4 or DF91, and this is followed by a 1S5, or DAF91, as second detector, A.V.C., and first audio. The output stage is a 1S4, 3S4, or DL92. If either of the latter types is used, the only difference in connections will be that the two sections of the filament will have to be connected in parallel to work off 1.4 volts. In other respects all three tubes are identical.

A.V.C. is applied to all three of the valves in the R.F. end. Since they are all zero-bias types, no bias battery is needed, and the only valve requiring special bias arrangements is the output valve. For this, back bias is used.

In our case, the on/off switch was on the volume control potentiometer, as we were able to find one with a double-pole switch. This enabled us to switch both the A and B batteries simultaneously, thereby protecting the B battery from accidental discharge in the case of a defective H.T. bypass condenser. However, this is not very likely, so that if a potentiometer with a double switch cannot be obtained, a single switch can be used and only the A battery switched.

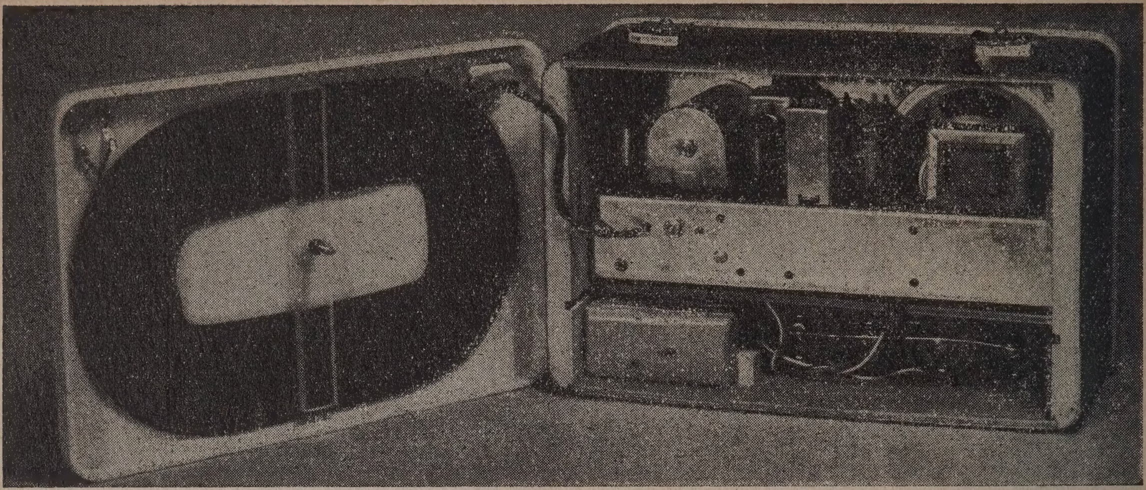
In building the set, only one difficulty is likely to be encountered—namely, feedback from the loop aerial to the rest of the circuit. When the prototype was built, instability from this cause was apparent at first, but it was found to be due simply to the fact that long leads had been run to the loop, and that no trouble had been taken to keep them clear of other parts of the set. After cleaning this up, no more trouble was experienced.

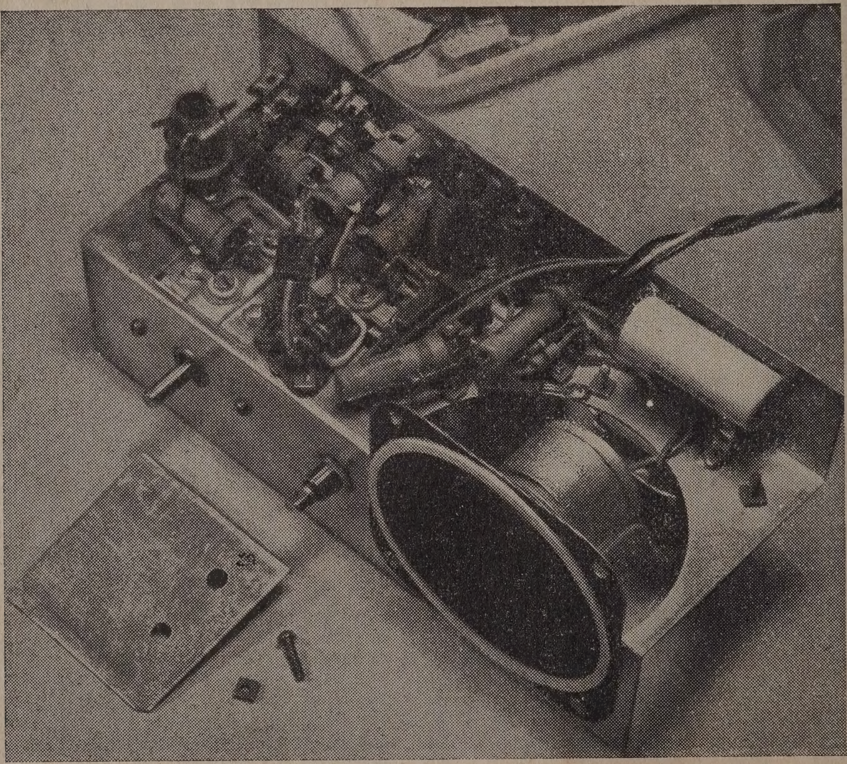
LAY-OUT OF PARTS

This can be seen in the photograph of the top of the chassis and in the general arrangement view of the set in the cabinet. On the right, looking from the back (as in the photograph, we see the output transformer and the loudspeaker. The latter is let into a cut-out on the chassis, provided for the purpose, and is screwed to the upright front flange. The shape of the cut-out can be seen in the under-chassis view. Now, looking at the other end of the chassis, we have the R.F. amplifier valve in the left-hand front corner, to the left of the gang condenser. Then in a row immediately on the right of the gang is the mixer valve, the first I.F. transformer, and the I.F. amplifier valve. Of these, the mixer valve is nearest the front of the chassis. The circuit then progresses to the right along the back of the chassis, with the second I.F. transformer and the detector and first audio valve and the output valve. The latter is the one at the back of the chassis, while the top of the 1S5 (or DAF91) can be seen between the volume control and the second I.F. transformer.

Looking at the underneath view, we can see the underneath part of the gang condenser, which is visible through a cut-out, provided so that the built-in trimmers can be got at for alignment purposes. In this photograph, the R.F. coil can be seen at the extreme left-hand end of the chassis, and the oscillator coil is mounted on the back flange, to the right of the gang condenser. The large white condenser directly behind the speaker is the bypass for the back-bias resistor.

In the general arrangement view, the loop leads can be seen going through a small hole in the chassis. They are twisted in order to reduce radiation from

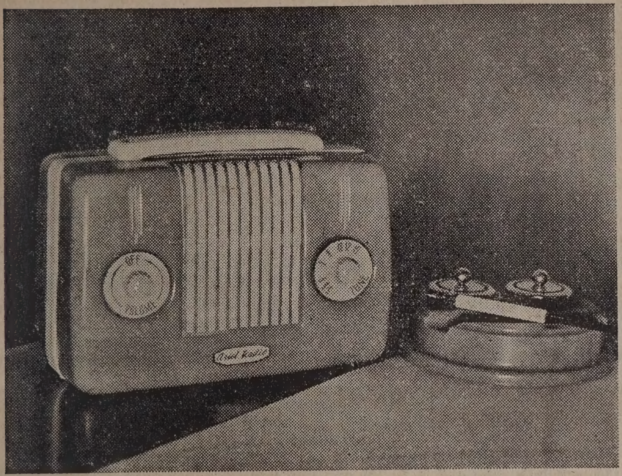




them, and this helps considerably in preventing feedback and oscillation. The method of mounting the plastic loop can also be seen quite clearly. This is simply a bar of perspex (used because of its low-loss properties) held to the back of the cabinet with a nut and bolt. When this is screwed up it holds the loop very firmly. In the upper right-hand corner of the back is a small trimmer. This is the loop trimmer, and is placed here to enable it to be adjusted through a small hole in the back, AFTER the set has been placed in the cabinet. This enables much better and more accurate alignment of the loop to be done, with a consequent improvement in performance. The placing of the loop close to the chassis, which happens when the set is closed up, has quite a large effect on the inductance of the loop, and so, without the trimmer which is get-at-able once the whole thing is closed in, it would not be possible to realize such good alignment. Of course, since this trimmer is used, the one on the R.F. section of the gang condenser has to be rendered inoperative.

In the opposite top corner of the lid are to be

Three New KITSETS



5-VALVE A.C. AND BATTERY PORTABLE

with everything necessary to build a super completely self-contained A.C. and Battery Portable. Five midget valves plus a selenium rectifier and all the best available components to build this peppy plastic-cased portable cost you only £16/15/-

•

5 VALVE BATTERY PORTABLE

This is the same set as above except for the fact that it is for battery operation only. The same smart moulded plastic cabinet measuring only 4 in. x 6 in. x 9½in. and in a choice of three colours, Maroon, Grey, or Bright Red, is used, and all components are of the highest quality. Complete in all details and with circuit and layout diagrams, this kitset is priced at £ 14 - 5 0.

FOUR VALVE T.R.F.

Here is a T.R.F. which *really* performs. The latest in bedside or "extra" radios. You can build this in no time and be sure of having a worthwhile set. With its carefully designed coils, these sets will separate all local stations without difficulty, and the kit comes complete with 5 in. Rola speaker and attractive veneered cabinet. £ 8 - 10 0.

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seen two further bolts passing through the lid, and with solder lugs and wires attached. These act as terminals for the primary coil, which is built into the loop and is part of it. This winding enables an external aerial to be used if desired.

In the under-chassis picture there appears in the foreground a small metal plate with two holes in it. As can be seen, this plate has a narrow flange on the side nearest the set. By this flange, it is attached to the left-hand corner of the back flange of the chassis. A close look will reveal one of the mounting holes, very near to the corner of the chassis flange. When in position, the plate is parallel to the chassis, and covers the R.F. coil. Its purpose is to help in shielding the R.F. coil from the loop, and it was found very effective in this respect. Without it, complete stability at the low-frequency end of the band was not obtained, but, with it in position, all was well. The holes in the shield plate are placed immediately above the back two trimmers of the gang, so that these can be adjusted without removing the plate.

An important point about the wiring is that the centre section of the gang is used for the oscillator and the front section for the mixer grid. This removes the R.F. section as far as possible from the aerial section, and assists in getting stability. In the photograph the wire from the grid winding of the R.F. coil can be seen going to the front section of the gang.

One small feature of the wiring that helps considerably in reducing the congestion under the chassis is that some of the bypass condensers are mounted vertically, with their earthed leads soldered directly to the turned-down flange at the back of the chassis. This can be seen in the underneath view.

ALIGNMENT OF THE SET

There are no essential differences between the alignment of a portable set and that of a full-sized one, since the method is exactly the same in each case. However, in this case, we have used a loop which, according to the makers, has slightly more inductance than is needed. As a result, it is possible, and also desirable, to adjust the loop inductance as well as the loop trimmer. With most loops, which are wound in slots in a former and cemented in place,

(Continued on page 26.)

A Simple Stroboscopic Lamp Using A 5-Watt Neon Bulb

There are many applications for a stroboscopic lamp. It can be used for observing a wide variety of periodic mechanical movements, including the cone of a loudspeaker and rotating machinery. If calibrated, it can also be used to measure the speed of the latter. Most modern instruments use a special 'strobotron" lamp for this purpose, but the humble low-powered neon can be used quite successfully, as this article shows.

Last month we published a short article showing a few of the interesting operations that can be performed by the electronic switching action of the multivibrator. This gave us the idea of designing a simple and inexpensive stroboscopic lamp, since the multivibrator can very conveniently be used as the basis of such a gadget. However, as far as usefulness is concerned, in a wide variety of applications, the stroboscope is far from being simply a "gadget" in the sense that it is amusing to watch, but has no real value. One person to whom it can be very useful is the electrician concerned with the installation of electric motors. Very often trouble is experienced for no apparent reason, with vibration of a motor on its mounting. With a stroboscope, the frequency and amplitude of the vibration can easily be measured, and the actual form of the vibration studied in slow motion. These facilities will always enable a cure to be effected. The speed of any rotating shaft can be measured, as long as it is possible to make a mark on the shaft. That is to say, the speed of small motors which have not enough power to drive a revolution counter can be found more accurately than by any other method. It is possible to observe in slow motion the way in which a speaker cone moves in and out, and to note any distortion of the cone that may take place when the speaker is under load. For instance, it is possible to see whether the voice-coil is being pushed outside the inter-pole space, and therefore to estimate when this cause of overload is operating. It is also possible to directly observe whether cone "break up" is taking place. That is, if the cone is no longer vibrating as a whole, but some part of it is executing an harmonic vibration and thereby causing distortion. Many other uses will suggest themselves, such as observation of the frequency of vibrator reeds. In fact, it would not be too much to say that enough uses can be found for such an instrument round the electronic laboratory or even the service workshop.

PRINCIPLE OF THE STROBOSCOPE

As with moving pictures, television, and the ordinary oscilloscope, our old friend persistence of vision makes possible the "tricks" that the stroboscope can do. Its principle is simply that of a lamp which is switched on for exceedingly short periods, at a predetermined rate. How this is done does not really concern us, as far as the operation of the device goes. For example, supposing we have a shaft, rotating at a constant speed. On this shaft we put a dab of paint, which serves simply to distinguish one part of the shaft from the rest of it. Now we turn on our flashing lamp and adjust the rate of the flashes until this is exactly the same as the rate of revolution of the shaft. We will now find that the shaft appears stationary and that the outline of the dab of paint can be seen quite clearly and distinctly, apart from a very slight blurring effect., which may or may not be present. Why do we see this? Simply because we only see anything at the moment the lamp flashes, and because the rate of the shaft and that of the lamp are identical. Thus, supposing the spot of paint is in a certain position when the first flash occurs. Exactly one revolution later, the spot is in exactly the same position, when, because of the synchronism between the shaft and the lamp, another flash occurs, and shows us the spot again, but still in its original position. Because of the persistence of vision, the eye does not perceive the fact that it is actually stimulated for only a very small fraction of a second, and therefore has the impression of continuous illumination.

Now, suppose that the lamp is flashing very nearly at the same rate as the shaft revolves, but not quite. In this case, the spot will not quite occupy the same position at the time of successive flashes, and the effect will be that of watching the shaft revolve slowly. The more nearly the flashes are synchronized with the rotation, the slower will be the apparent movement. Further, if the flashing rate is slower than

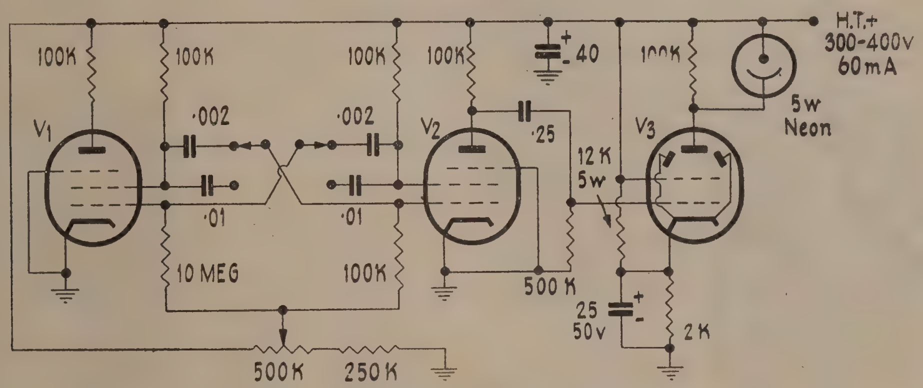


Fig. 1.—Circuit of the stroboscopic lamp.

the rotation of the shaft, the latter will appear to turn backwards, and, if faster, the rotation will appear to be in the correct direction.

The above few paragraphs, then, show that for stroboscopic observation of a moving object, we must be able to control the rate of revolution of the object, or else the rate of flashing of the lamp. In general, it is not very convenient to do the former, because the rotating machinery is usually supposed to operate at fixed speed, and, in any case, if we wish to find the speed when this is determined by the operating conditions of the machine, we certainly do not want to vary this purposely. However, a simple example of a stroboscopic light is the disc that is placed on a gramophone turntable and observed by means of a lamp lit by the 50 c/sec. mains, to see whether the speed is correct or not. In this case, the motor is fitted with a governor and the light frequency is fixed, but the principle of the operation is exactly the same as already described.

The question now arises as to how we are to flash a lamp in a suitable manner. In other words, how short must the flash be compared with the time of one cycle of the recurrent phenomenon we wish to observe? And what range of frequencies will the equipment have to provide? Also, are there any special requirements for the lamp itself, and, if not, why do we use a neon lamp instead of a simple incandescent type?

It will be worth while to answer all these questions before we go on to describe the circuit that has been developed to do the job, for if we do this, readers will have a far better idea of what the circuit is supposed to do.

FLASHING RATE

In general, the use of the stroboscope is in the investigation of things mechanical. For example, it can be used for finding the speed of small petrol engines, such as are used to drive model aircraft, or to see how fast a given electric motor will revolve under different conditions of load, and for many other jobs as well. This being the case, the flashing frequency need not be very high. Not many machines revolve faster than, say, 12,000 revolutions per minute. This is 200 revolutions per second, so that, to observe even as high a speed as this, we need only flash the lamp 200 times a second. Thus, the highest frequency at which the lamp is likely to be operated is at 200 c/sec. Thus, there are no difficulties likely to be met in the circuitry on account of extra high-frequency pulsing or anything of that kind. At the other end of the scale, we find that quite slow flashing rates are needed if slow-moving machinery is to be observed and its rate measured. We can usefully take the rate of flashing down as low as 5 c/sec., since even this represents a rate of 300 r.p.m. in terms of a revolving shaft. However, as we shall see, this introduces no difficulties either, and for observing even slower rates, a special dodge can be used which makes very slow-flashing frequencies unnecessary.

DURATION OF THE FLASH

A little thought will show that one of the most important things about the stroboscopic lamp is the duration of each flash. The reason is that, unless the flashes are of very short duration, the picture we get of the arrested motion will be blurred. Ideally, the shorter the flash, the better, for any blurring that results is due simply to the fact that the shaft, or other moving object, is, in fact, moving very fast, so that, if each flash lasts too long, it will have had time to move an appreciable fraction of a turn while the flash is on, and the impression we get will not be

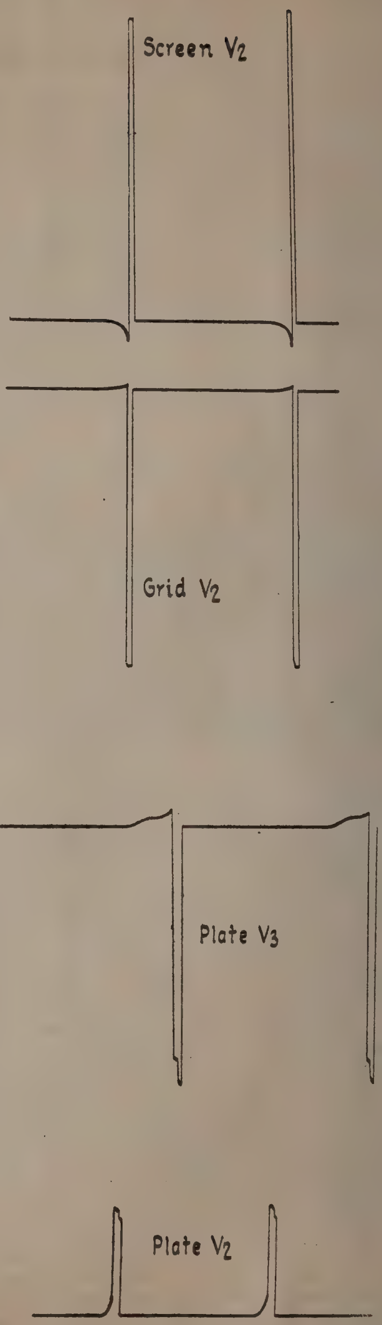
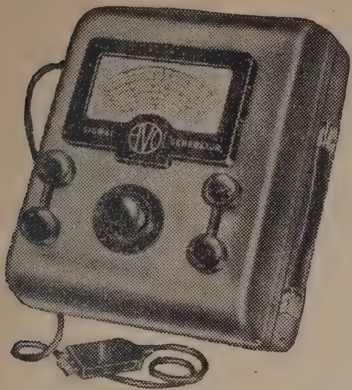


Fig. 2.—Waveforms to be found in the circuit of Fig. 1. As explained in the text, the waveforms for V_1 are the exact inverse of the ones shown. These are not drawn to scale in order to show more detail in the fast transitions.



Wide-range Signal Generator

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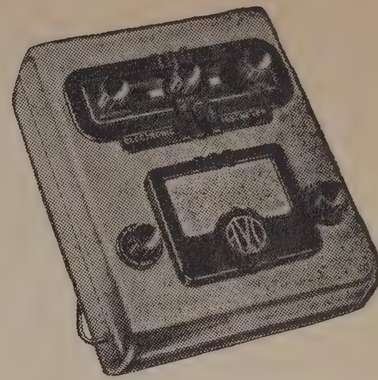

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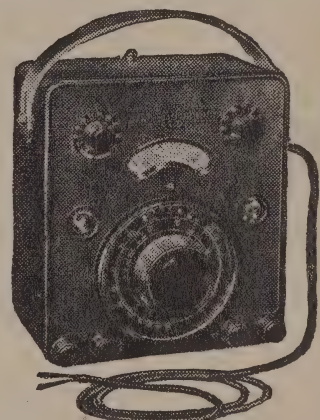
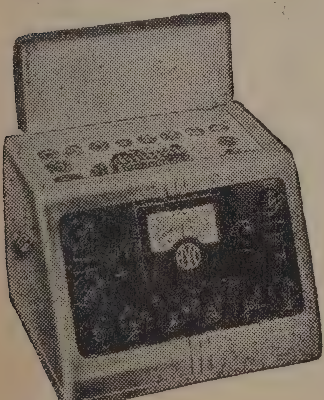


Avo Test Bridge



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sharp. This problem is exactly the same one that is encountered in attempting to photograph rapidly moving objects. In order to "stop" the motion and give a sharp picture, a very short exposure time must be used, and the faster the movement the shorter must the exposure be.

We see, therefore, that for a sharp picture to be obtained, the flash must last for only a very small fraction of the flashing cycle. That is to say, if we have 100 flashes a second, the complete flashing cycle occupies a hundredth of a second, and for the result to be satisfactory, the actual flash must not last longer than, say, a hundredth of this time, or, in figures, one-ten-thousandth of a second. Luckily, when the flashing rate is lower, we do not need to keep the actual time of the flash constant, since we will get the same visual result as long as the "on" time of the lamp is the same fraction of the complete cycle. In other words, for a rate of only 10 flashes a second, we can do with a flash length of a hundredth of the time of one cycle, so that, this time, the duration of the flash need be only one-thousandth of a second. This is fortunate, because it is much easier to keep the on/off time ratio constant, irrespective of the flashing rate, than it would be to keep the "on" time constant for all flashing frequencies. Once we have built the circuit, it takes care of this question automatically, and we do not have to bother about it.

The above paragraphs show, quite clearly, why it is that we cannot use an ordinary filament-type lamp in a stroboscope. It is simply that it is not possible to turn a filament lamp on and off in the exceedingly short periods allowed to us. For instance, if current is suddenly switched to an ordinary lamp, it takes considerably longer than the period we need before the filament gets hot enough to show any light. Thus, if we attempted to pulse this kind of lamp on for such a short period as one-ten-thousandth of a second, or even one-thousandth, of a second, the result would be nil, because the lamp would not show any light before the current was switched off again! Because of this, we must use some form of gaseous discharge lamp. These, of which the ordinary neon lamp is the commonest, have the ability to glow almost instantaneously when voltage is applied to them. Also, when the current to them is switched off, the light disappears almost instantaneously, too, so that extremely short flashes are possible. Actually, there is a limit to the rate at which a neon lamp can be switched on and off, but we do not need to worry about it for this purpose, as the critical rate is much higher than those in which we are interested for the stroboscope.

QUANTITY OF LIGHT

The neon, then, will allow us to get the very short flashes that are needed. Unfortunately, however, there is another consideration, and that is the amount of light that a small neon lamp will provide. For example, a neon the size of a 60-watt filament lamp is rated at only 5 watts, and 5 watts does not represent a great deal of light. We want our stroboscope to be effective in daylight, if possible, and we certainly do not want to have to do our testing in the dark. It is to get over this difficulty that special stroboscopic lamps have been developed, under the name of "strobostrons" and other trade names. Their special characteristic is that they produce a very intense flash, of a better colour for seeing purposes than the orange-red of the neon lamp. However, these special lamps are expensive, and it is still possible to get satisfactory results with a simple neon, if it is modified by taking out of the base the high-value resistor that is there. In fact, in a 5-watt neon lamp, most of these watts are actually dissipated in the resistor, only about 1.5 watts going into the lamp itself. In practice, we overcome this difficulty by removing the resistor and also by making the lamp pass far more than its normal current for the short period of each flash. As a result, the brilliance of the flash

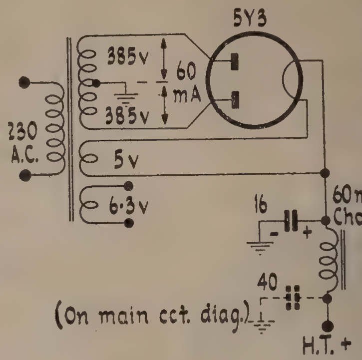


Fig. 3.—Suitable power supply for the stroboscope. A transformer of only 60 ma. H.T. capacity is needed because the 6V6 pulse amplifier draws only 5 ma. or so, being cut off for most of the time.

is far greater than that of the lamp used in the normal way; so much brighter is it that, when the stroboscope is working, the lamp appears even brighter than it does when connected to the 50-cycle mains in the ordinary way. Measurements taken on the circuit in our laboratory showed that at each flash the current through the lamp was almost 500 ma.

It may be asked, then, whether the lamp will stand up to such treatment. It will, because the period during which the heavy current passes is so short that the average power dissipated by the lamp is little more that 1.5 watts. During the flash, the power dissipated is almost 50 watts, which accounts for the individual flashes being rather more brilliant than usual. In fact, if the flashing rate is reduced until the individual flashes can be easily seen, it is appreciated just how bright the flashes are—bright enough to make it extremely unpleasant to look at them for more than a second or two.

ELECTRICAL PRINCIPLES

Having determined that a neon lamp makes a satisfactory source, the question arises of how we are to bring about the brief periodic flashes. It is at this point that our old friend, the multivibrator, comes to our aid. A multivibrator circuit is set up, using two pentodes. These can be 6SJ7's, or any small voltage amplifier pentode, since the multivibrator does not itself provide the power to work the lamp. Fig. 1 shows the practical circuit of the stroboscope, while Fig. 3 shows the power supply. It will be seen that V_1 and V_2, the multivibrator valves, have identical grid coupling condensers, but that V_1 has a grid leak of 10 megs., while V_2 has one of only 100k. This unbalance in the circuit causes the output waveform to be

similarly unbalanced, as can be seen in the oscillograms of Fig. 2. Looking at the plate waveform of V_2, we can see that this tube is cut off for only very short periods, during which no voltage drop is produced across the 100k. plate load resistor. For the rest of the time, the valve is conducting, with the result that a large voltage drop occurs across the 100k. plate load resistor. Thus, the waveform at the plate of V_2 consists of very brief positive pulses, which are applied through the 0.25 μf. coupling condenser to the grid of V_3, which is a pulse amplifier, and has the job of actually turning the lamp on and off.

For the sake of clarity, the waveforms have not been drawn to scale, since, in practice, the pluse period is much shorter compared with the length of the whole multivibrator cycle. We have not shown the waveforms for V_1, but these can easily be imagined, because they are the exact opposite of the corresponding waveforms for V_2. For instance, the grid waveform of V_2 shows that a very large negative pulse is applied to its grid. Since this pulse comes from the screen of V_1, the waveform at this point must be similar to that shown for the V_2 grid. Similarly, the positive pulse at the screen of V_2 is transferred through the coupling condenser to the grid of V_1, so that these two waveforms are alike, too.

In the grid circuit, giving a source of variable positive bias to the lower ends of the grid leaks, is a 500k. potentiometer. This is the fine frequency control, and adjusts the rate of flashing by means of altering the multivibrator frequency. To get the required range and to make adjustment easier, we have switched the grid condensers to give two frequency ranges. The mark-space ratio, or the ratio between the on and off periods of the lamp, remains constant, irrespective of the frequency, because this is determined by the values of the grid leaks, which are the same at all times. As mentioned above, this is handy, for the average brilliance of the lamp remains reasonably constant, and also because the performance is similar whatever the speed of the moving object that is being observed.

THE PULSE AMPLIFIER

The pulse amplifier, V_3, uses a 6V6. A 100k. load resistor is connected in its plate circuit, and in parallel with it is the neon lamp. With this arrangement, it is easy to see that if the 6V6 is not conducting, there will be no voltage drop across the 100k. resistor, and thus no voltage across the lamp, which will therefore be out. Whenever the 6V6 conducts, however, a large voltage drop occurs across the 100k. resistor. Now, as soon as this drop reaches the striking voltage of the lamp, the latter will light. When lit, the lamp represents only a very low resistance, so that, as soon as it is struck, the 6V6 is able to pass a very heavy current. This is how the lamp comes to be turned on, but, to see how it is turned off, we must examine the

grid circuit of the 6V6 and also the pulse that is fed to it from the plate of V_2. The cathode of V_3, it will be noted, is at a fixed positive potential, determined by the voltage divider made up of the 12k. 5-watt resistor and the 2k. resistor between cathode and earth. This positive voltage on the cathode is in the region of 30 volts, and is enough to reduce the 6V6 to cut-off. When a positive pulse arrives from V_2, its amplitude is great enough to swing the 6V6 grid many volts positive. Thus, at a time corresponding with the leading edge of the pulse, V_3 conducts and triggers the lamp into operation. When the trailing edge of the pulse arrives, the 6V6 immediately becomes cut off once more, thereby extinguishing the lamp, because the only path for current through the lamp is also through V_3. The lamp therefore goes out until the next positive pulse comes along.

POWER SUPPLY

Although the lamp current is so great for the short time during which it is on, the on period is so small a fraction of the total time that the average current through it, and therefore through the 6V6 also, is very small. For this reason, a small 60 ma. power transformer is quite heavy enough to supply the power both for the valves and for the lamp itself. It will be seen that a 40 μf. electrolytic condenser has been used as the second filter condenser. The reason for this is not so much that a well-filtered D.C. supply is needed, but so that the condenser can supply the large lamp current during the on period. If only a small condenser is used here, there is a noticeable falling-off in brilliance, because the heavy lamp current completely discharges the reservoir condenser before the "on" pulse is over. In this way, the flash duration is shortened but the brightness is impaired.

The power supply is quite conventional and requires no special consideration apart from the large reservoir condenser. The average current through the 6V6 is only 5 ma. or so, with the result that there is no question of exceeding the plate dissipation or of damaging the cathode through excessive current drain during the conducting period.

USING THE INSTRUMENT

Many readers will be unfamiliar with the use of a stroboscope, and will no doubt be interested in knowing just how it is used in practice. Anyone who builds the circuit and wants something to make it work on, can use a small electric motor, such as an electrotor, in order to familiarize himself with the working of the stroboscope. First of all, it is a good idea to fit a small cardboard disc to the shaft and to put a black line or spot on it as a reference mark. Then the motor can be set turning and the stroboscope turned on. First of all, turn the coarse frequency control to the high range and the fine control to the H.T. end of its travel. This gives the highest flashing frequency. Place the lamp near the motor so that its light falls on the rotating disc and gradually turn the frequency control knob so as to progressively lower the frequency. While this is being done, watch the disc and make a mental note of the phenomena that occur. First of all, it will be seen that a number of spots appear on the disc at certain settings of the control. Further, as the frequency is reduced, positions will be found where four, three, and two stationary spots are visible. In between these positions, no spots are visible at all clearly, because the flashing rate bears no simple relation to the rate of revolution of the disc.

(Continued on page 33.)

FOR THE SERVICEMAN

THE ULTIMATE 7-VALVE BANDSPREAD MODEL R.O.

GENERAL DESCRIPTION

Basic Circuit:

A type 7B7 loctal pentode is used as a radio frequency amplifier with tuned input and inductive coupling to the grid of the frequency changer. The frequency changing stage utilizes an ECH21 loctal triode heptode in a tuned plate oscillator circuit. A three-gang condenser controls the R.F. stage, the frequency changer triode, and the frequency changer heptode.

A 7B7 loctal pentode as the intermediate amplifier follows, which is in turn coupled to a type 7C6 duo-diode triode combining the functions of detection, A.V.C. rectification, and voltage amplification. The triode section of the 7C6 is capacitively coupled to a type 7C5 beam power amplifier delivering approximately 4.5 watts of power to the 8 in. Rola speaker. Full-wave rectification is achieved by the use of a type 5Y3-G octal, and adequate filtering is provided by means of a brute force filter. The electron ray indicator is a type 6U5-G.

I.F. Alignment:

A signal generator modulated 30 per cent. at 400 cp/s. is coupled between the control grid of the ECH21 and ground by means of a 0.1 μf. condenser. I.F. cores should be adjusted in the following order: Diode core, 7B7 plate core, 7A8 plate core, 7B7 grid core. The adjustment is made for maximum output at 460 kc/s.

An input of 30 microvolts should produce an output of 50 milliwatts.

Calibration:

Shortwave Band 1.—Adjust 21.5 mc/s. point with T.14 and 17.8 mc/s. point by fanning shortwave oscillator coil inductance.

Shortwave Band 2.—Adjust 15.2 mc/s. point with T.13.

Shortwave Band 3.—Adjust 11.8 mc/s. point with T.12.

Shortwave Band 4.—Adjust 9.6 mc/s. point with T.11.

Broadcast: Adjust 1400 kc/s. point with trimmer T.15 and 600 kc/s. point with T.16. Adjust 1000 kc/s. point by means of iron core 3.

R.F. Alignment:

Shortwave Band 1.—A signal generator is coupled to the antenna coil by means of a standard dummy antenna. Adjust for maximum output the 21.5 mc/s. point with T.4 and T.9 and the 17.8 mc/s. point by means of fanning antenna and detector coil inductances.

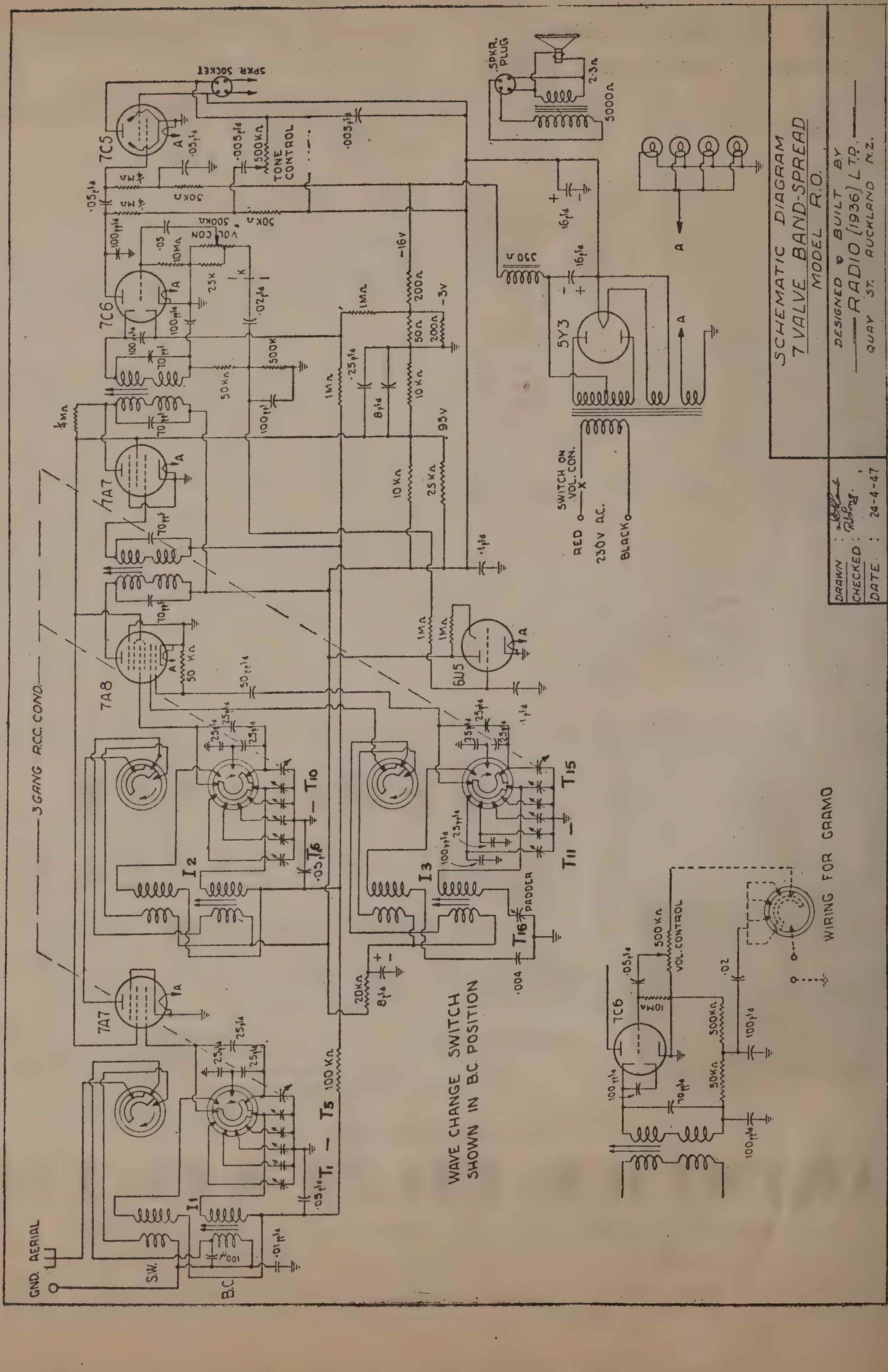
Shortwave Band 2.—Adjust 15.2 mc/s. point with T.3 and T.8.

Shortwave Band 3.—Adjust 11.8 mc/s. point with T.2 and T.7.

Shortwave Band 4.—Adjust 9.6 mc/s point with T.1 and T.6.

Broadcast.—Adjust for maximum output 1400 kc/s. point with T.5 and T.10. Adjust for maximum output 600 kc/s. point by means of iron cores 1 and 2.

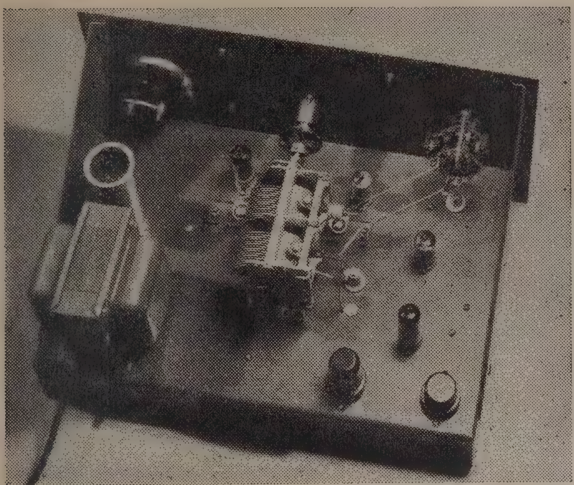
(For circuit, please see next page.)


SCHEMATIC DIAGRAM
7 VALVE BAND-SPREAD
MODEL R.O.
DESIGNED & BUILT BY
RADIO (1936) LTD.
QUAY ST. AUCKLAND N.Z.
DRAWN :
CHECKED :
DATE : 24-4-47
WAVE CHANGE SWITCH
SHOWN IN B.C. POSITION
WIRING FOR GRAMO
3 GANG R.C.C. COND.
SPKR. SOCKET
SPKR. PLUG
TONE CONTROL
VOL. CON.
SWITCH ON VOL. CON.
RED
230V A.C.
BLACK
GND.
AERIAL
S.W.
B.C.
7A7
7A8
7A7
7C6
7C5
6U5
5Y3
PADDER
I1
I2
I3
T1 — T5
T6 — T10
T11 — T15
T16
VOL. CONTROL
-16V
-3V
95V

THE "RADEL" AUDIO SIGNAL GENERATOR

PART 2

(Note.—The full circuit of this instrument was printed in the December, 1949, issue of this magazine.)



The addition of the attenuator greatly increases the usefulness of the signal generator, since, without any auxiliary equipment at all, it is possible to make gain measurements. It is also possible to test microphone pre-amplifiers and other low-level stages with known input voltages of the same order as they are expected to handle in use. At the same time, the output voltage is great enough for fully loading many power amplifier valves, without the use of additional amplifier stages. It is thus possible to test amplifiers right from input stage to output stage, in exactly the same way as the radio frequency end of a receiver can be tested with an R.F. signal generator. The attenuator can, of course, be omitted if desired, but it takes very little work to add, and, with a little trouble taken over adjusting the resistors to the exact values, can be made very accurate. Incidentally, the equipment needed for adjusting the resistors is a milliammeter and an accumulator, to use as a standard voltage.

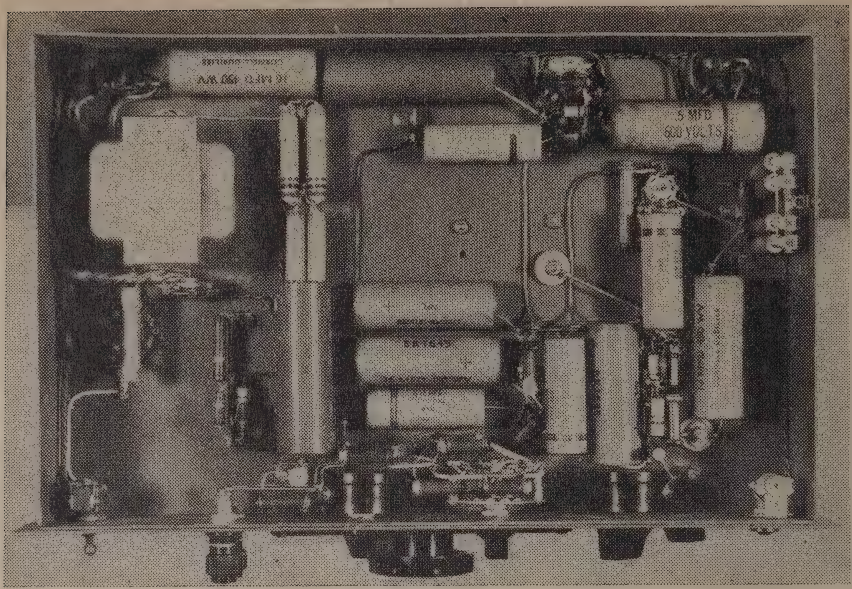
THE CIRCUIT IN DETAIL

First of all, let us look at the circuit of the oscillation amplifier, which consists of V_1 and V_2; the circuit is that of a straightforward resistance-capacity coupled amplifier, in which V_1 is a voltage amplifier, and V_2, employing a resistance load, R_8, is a power amplifier as well as a voltage amplifier. However, forgetting this aspect for the moment, and regarding only the arrangement without noticing the circuit values, it is seen that the amplifier contains two sources of negative feedback. The first is that both cathodes are unbypassed, the result being that each stage has less voltage gain that it could be made to have. This is done purposely, because, strange as it may appear, the two stages are required to have an overall amplification of only three times, approximately, in order to sustain oscillation. Why, then, do we use two stages? it may be asked. The reason is simply that there must be two stages in order that the output of the amplifier shall be in phase with the input, and therefore sustain oscillation at the frequency where the phase-shift through the network is zero. The low gain requirement is a consequence of the fact that the attenuation caused by the network is only about three times. Thus, in order that the whole system shall oscillate, it is only necessary for the amplifier gain to be great enough to offset this small loss through the network. There is also a second and very important result of these amplifier measurements—namely, that when we have to use two stages of amplification, as here, in order to get such a low total gain, it is possible to apply an extremely high degree of negative feedback. In fact, it is essential to do so if the gain is to be as low as it must be.

At this point, readers may ask, "Why not cut down the overall gain by some simpler method, such as having a fixed gain control or attenuator between the stages?" This would be easy enough to do, but then we would lost the incidental but very important advantages of the negative feedback. By doing things the way we have done, we ensure that as long as the amplitude of oscillation is kept small, the distortion in the output will be exceedingly low. In a high-quality audio oscillator, this is a most important consideration, and merits a good deal of trouble to attain.

Because of all this, then, we reduce the gain of each stage separately by leaving the cathode resistors unbypassed. Further, we take a very large fraction of the output voltage and feed it back to the cathode circuit of V_1. The electrolytic condenser, C_4, is a blocking condenser, and the proportion of the output voltage fed back is determined by the voltage divider R_7, R_5, and R_6. The latter is made variable and is brought out to the front panel of the instrument. It serves to control the amount of amplification of the two stages, and therefore it controls the amplitude of oscillation. Now, if this is held constant, it can reasonably be assumed that the distortion level at all frequencies will be very low and approximately constant throughout the frequency range of the oscillator. Incidentally, unless the large amount of negative feedback were used, it would not be possible to get similar performance at the extreme ends of the frequency scale, but, with the instrument as built, the waveform is the same at 30 c/sec. as it is at 1000 c/sec., and the output is easily adjusted by means of R_6 to be equal at all frequencies, as indicated on the output meter.

The frequency determining network is connected between C_4 and the control grid of V_1. The different ranges, of which there are three, are obtained by switching in different pairs of resistors. Reference to the component list shows that R_{10} and R_{35} are 10 megs. each, and that the other two pairs of resistors are 1 meg. and 100k. respectively. Tuning is performed by a two-gang condenser of the radio receiver type, with sections of 420 $\mu\mu$f. maximum capacity. This condenser is labelled C_{18} on the circuit diagram. Unfortunately, the circuit does not allow the frame of the gang condenser to be grounded, with the result that the frame is at a very high impedance level with respect to the chassis—10 megs. on the low-frequency range. This means that the gang has to be very well insulated from the chassis, and that a well-insulated flexible coupling has to be used to attach the shaft



to the dial mechanism. Another unfortunate consequence is that the stray capacities across the individual resistors are badly unbalanced because of the high capacity of the frame to earth. However, this is taken care of by adding a 3-30 $\mu\mu$f. Philips trimmer in parallel with the upper section. This condenser, C_{10}, has to be adjusted carefully, but the one setting does for all frequency bands. The two fixed condensers, C_{11} and C_{12}, are 15 $\mu\mu$f. silvered ceramic midgets, connected one in parallel with each gang section. It is by means of these condensers, which increase the minimum capacity somewhat, that we have been enabled to eliminate the use of a four-gang condenser, such as practically all commercial instruments of this type use. Investigation of the circuit, coupled with experience of a similar oscillator using a four-gang condenser, brought us to the conclusion that the main reason for using a four-section condenser was simply to increase the minimum capacity to the point where stable operation takes place at all dial settings. With too low a minimum, oscillation is difficult to secure at low-capacity settings of the gang. In general, adding fixed condensers to increase the minimum is not always a good thing, as it decreases at the same time the range of capacity variation, and therefore the range of frequencies that can be had on any one band. However, with the type of condenser used in the prototype, and no added capacity, it was found that a frequency range of 13 to 1 was possible. Adding the 15 $\mu\mu$f. condensers reduced this only to just over 10 to 1, which is a very desirable figure to use, since it enables resistors to be used in 10 to 1 steps for getting complete coverage.

THE AMPLIFIER

V_3 and V_4 comprise a separate amplifier, quite independent of the oscillation amplifier we have just been discussing. However, its circuit is almost identical with that of the oscillator, with the exception that no variation of negative feedback is provided, since it is not needed. Input to V_3 is taken from the cathode of V_2 via a conventional R-C coupling. The same large degree of negative feedback is used, however, because the amplifier is again called upon to give only a very slight voltage gain. Its job is twofold. First, it must isolate the output circuit (attenuator, etc.) from the oscillator circuit, so that alteration of output voltage will have no possible effect on the gain or feedback in the oscillator amplifier. Secondly, it must provide power amplification, in order that an output voltage may be developed across the low-impedance of the output attenuator. The power delivered to the attenuator is 100 milliwatts—not very much, certainly, but enough to necessitate the use of quite a large power valve. The reason, of course, is that the available output power of a tube with a resistance load is very small because most of the available output power is dissipated in the load resistor itself. In this case, the actual power delivered by the valve is 200 milliwatts, half of which is dissipated in the plate resistor, R_{19}, in parallel with the feedback resistor, R_{18}, the other half being dissipated in the useful load, which is the output attenuator.

The network in the cathode circuit is simply a means of adjusting the input voltage to the metering circuit to a convenient value, and only the total resistance between the V_4 cathode and earth has any bearing on the amplifier performance.

THE OUTPUT ARRANGEMENTS

It will be seen that at no point in the whole oscillator-amplifier set-up is there a normal "volume control." The feedback control on the oscillator circuit is used to set the oscillation amplitude, whereupon the full oscillator output at the cathode of V_2 is fed to the grid of V_3. We are able to do this because the output at the V_1 cathode is only about 3 volts R.M.S., which cannot possibly overload the grid of V_3, owing again to the negative feedback. Under these conditions, it is possible to set the output voltage at the plate of V_4 to approximately 10 volts, or higher, but not lower. This is because, when the feedback

Announcing yet another Australian valve development

6AR7 G·T

HIGH-GAIN

DUO-DIODE PENTODE

WITH "FORMED" GRID CONSTRUCTION

Completely shelf-shielded, internally as well as externally, its super-control characteristic enables the 6AR7-GT to handle the high signal levels without distortion.

Outstanding performance is achieved when the 6AR7-GT is used in the intermediate frequency-detector stages of straight and reflexed broadcast receivers circuits. Its development by Amalgamated Wireless Valve Company makes possible the manufacture of low-priced, 4-valve radio receivers providing sensitivities of the order of from 20 to 25 micro-volts in straight sets and from 1 to 2 micro-volts in reflexed versions.

RADIOTRON 6AR7-GT
Typical Operating Conditions
(Pentode Unit)

Ef	6.3 Volts
If	0.3 Amp.
Eb	250 Volts
Ec2	100 Volts
Ec1	–2 Volts
Gm	2500 Micromhos
Rp	1.0 Megohms

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control, R_6, is adjusted so that the circuit is just on the point of oscillation, the output from V_4 is 10 volts. At this point it will be found that the circuit is undecided about whether it will oscillate or not, and the output indicator needle fluctuates in a random fashion just before oscillation slowly decays to zero. It is thus necessary to work with an output from the amplifier of just over 10 volts R.M.S. in order that the oscillator shall operate positively, albeit very weakly. Thus, we work with an output at the plate of V_4 of approximately 12.5 volts R.M.S. by dint of adjusting R_6 so that the output is just a trifle greater than the minimum possible before oscillation ceases. Now the output level indicator circuit is attached to V_4, and gives us a measure of the output voltage at all times. After the circuit has been wired up and the oscillator has been adjusted by the procedure to be detailed later, all we have to do is to adjust R_6 until the output at the plate of V_4, as measured by some independent means, is 12.5 volts, and then put a red mark on the output meter scale at the point reached by the pointer under these conditions. Then, whenever the feedback control is adjusted so that the meter needle comes to the red mark, we know that the output voltage at the plate of V_4 is 12.5.

At this point, we must consider the output attenuator and how it works. Reference to the circuit diagram shows that R_{19} and R_{18} are both 2000 ohms. Now, the plate impedance of V_4 is several hundred thousands of ohms, so that, without much error, we can say that the impedance between the plate of V_4 and earth is 1000 ohms. If now we wish to reduce the voltage which we draw from the amplifier, there are two possible ways of tackling the problem. The first is simply to connect a high-resistance potentiometer from plate to earth, and to take the output from the moving arm. This scheme, however, has very little to recommend it, because we would never be able to tell how much voltage we were getting out of the generator into the equipment under test. Also, such an arrangement would not have a flat frequency response, and all the trouble we have taken to produce a constant output voltage, irrespective of frequency, would be wasted.

The alternative is to use a low-impedance potentiometer, of total impedance equal to 1000 ohms. This can be done quite easily. Furthermore, the low output impedance would enable us to be reasonably certain that connecting the output terminal to an amplifier or other device to be tested would not affect the voltage delivered. It would be possible to calibrate the 1000-ohm potentiometer from 0 to 10 volts in steps of 1 volt, so that, within limits, the generator could be used to measure the gain of amplifier stages. However, much smaller outputs than 1 volt are frequently needed, so that, although the scheme we have just outlined would be far better than the first one, we could do with some means of getting lower known output voltages than 1 volt. One way of doing this would be to put a gain control in the amplifier circuit, but there are a number of good reasons for not doing it that way.

The only remaining possibility is to insert attenuators between the 12.5 volt maximum output of the generator and the 1000-ohm output potentiometer, and this is the scheme that has been used, and which is shown in the circuit diagram. There are three attenuator sections in all, and each is a T section. The first section comprises R_{25}, R_{26}, and R_{27}. The resistors used are ordinary carbon types, adjusted by hand to specified values, of which more anon. The second and third sections of the attenuator are also T-pads, and the switching performed by S_2 (a, b, and c) does the following. In the position drawn, the second and third sections are out of circuit, while R_{34}, the 1000-ohm potentiometer, is connected at the output of the first section. It will be remembered that the voltage at the plate of V_4 is 12.5, and that we want a maximum voltage of 10 across the 1000-ohm pot. Thus, the job of the first section of the attenuator is simply to cut the output from 12.5 to 10 volts. On the next position of the switch, the second T section is connected to the output of the first, and the 1000-ohm pot. is connected across the output of the second section. This section is arranged to give an attenuation of 20 db., or, in other words, a reduction in output voltage to a tenth. Thus, in the second position of the switch, the maximum voltage across the potentiometer is 1v. instead of 10v. Now, if the pot. has been calibrated in steps from 1 to 10, each division will now equal 0.1v. We can therefore get any voltage from 0.1 to 10 by using the switch and the potentiometer. The third position of the switch connects in a further 20 db. attenuator section, so that here the maximum output of the potentiometer is 0.1v., and the divisions on the scale will be equal to 0.01v., or 10 millivolts. Thus, by the addition of six carbon resistors and a switch, we very greatly increase the usefulness of the oscillator. The output range is now from less than 10 millivolts to 10 volts. At this, the generator can be used to test almost any amplifier stage, from microphone pre-amplifiers to power valves. It can also be used to measure stage gains and to estimate the output voltages of microphones and gramophone pick-ups.

THE OUTPUT LEVEL INDICATOR

The sole remaining part of the circuit to describe is the level indicator circuit. This is a simple amplifier-rectifier combination, using a 6C5 and a 6H6 in conjunction with a 0-500 amp. moving coil meter. Its response is flat to frequencies well outside the range of the oscillator, so that no correction has to be made for frequency. With the circuit values given, the meter reads 0.6 of full-scale—i.e., 300 amps., when the output from the plate of the output valve is 12.5 volts. In individual instruments it is unlikely that the same figure exactly will be obtained, owing to differences in tube characteristics and resistor values, etc., hence the recommendation above to measure the exact output by some independent means, and then to place a special mark on the meter scale. It would be possible to have a calibrating potentiometer which would allow the meter to be set exactly to one of its own marks, but this not such a good idea from the point of view of stability, since a pre-set control can easily be shifted accidentally.

The power supply is conventional, and does not require extensive filtering. The 100-ohm resistor, R_{38}, is included so that the H.T. voltage will be exactly 250 volts when a 310 volt-a-side power transformer is used with condenser-input filtering.

CONSTRUCTION

In last month's instalment of this article, a photograph was shown of the front panel of the audio oscillator, and here we show two other photographs which will help to illustrate the lay-out and type of construction used.

The instrument is built on a chassis 14 in. x 9 in. x $2\frac{1}{2}$ in., with a front panel 15 in. x 9 in. In the centre of the panel is the tuning dial. To its right is the 0-500 amp. output level meter, while in a corresponding position on the other side is the range switch. These parts can be seen in both the front and back views. Under these, in a row, are to be found, reading from left to right, the oscillation amplitude control, R_6, the stepped attenuator, S_2, and the output potentiometer, R_{34}. Then comes the output and earth terminals and the mains on/off switch, S_3. At the extreme left-hand end of the row is the pilot-light bezel.

Now, referring to the top-chassis view, we see that behind the output meter, at the back of the chassis, are the rectifier and power transformer. In the centre of the chassis is the two-gang tuning condenser, and in the other back corner are the output meter valves, V_6 and V_7. Between these and the range switch are V_1 and V_2, the former towards the end of the chassis, while the two amplifier valves, V_3 and V_4, can be seen on either side of the gang condenser, in a line parallel with the front panel.

It can thus be seen that there is plenty of room above the chassis, but a reference to the underneath view shows that the space underneath, though not over-crowded, is quite fully occupied. The power choke can be seen in the right-hand front corner in this photograph, underneath the power transformer and close to the rectifier socket. Unfortunately, it is difficult to pick out the miniature valve sockets, which are dwarfed by the large coupling condensers. However, their positions can be gauged by comparing this photograph with that of the top view.

Since the frequency network contains such high resistances, an essential feature of the construction is good insulation in this part of the circuit. The gang condenser has to be insulated from the chassis, and, so that there shall be no leakage, the gang is mounted on perspex, which has most excellent insulating properties. A careful look at the top view will reveal a strip of this material, 5 in. x $\frac{3}{4}$ in. x $\frac{1}{4}$ in., which is used to stand the front mounting bracket on. A short post of the same material is used to support the back mounting lug of the condenser. The front strip is raised $\frac{7}{8}$ in. above the chassis, so as to reduce to a reasonable figure the unavoidable capacity between the frame of the condenser and the chassis. Of course, an insulating coupling must be used between the condenser shaft and the dial movement, and this should preferably employ ceramic insulation.

In the photograph, two stout bare copper leads can be seen going above the chassis from the gang to the range switch, and also visible are two ceramic feed-through insulators, connecting the network to the rest of the circuit below the chassis. One of these is

almost directly underneath the range switch, while the other is level with the back section of the gang, and a little to the right in the photograph. The undersides of these feed-throughs can be seen in the under-chassis view. One is in the clear space near the middle of the chassis and the other can be seen in the left-hand front top corner, slightly to the left of the oscillation control potentiometer. The socket of V_2 can be seen, midway between the V_6 and V_7 sockets, and farther towards the front panel. In front of this is a condenser, parallel with the sides of the chassis, and at the other end of this condenser, which is C_1 on the circuit diagram, is the V_1 socket, partially obscured by some small resistors. The bank of resistors to the left of the V_2 socket, mounted on the side of the chassis, is a complete resistor made up for the plate resistor of V_2.

It is better to use a number of carbon resistors rather than a wire-wound one in this position, because the latter type always has appreciable inductance, which will not necessarily assist the performance, as it may produce an unwanted peak in the response at some high frequency. A similar composite resistor is used for the plate circuit of V_4, and this can be seen to the left of the filter choke, mounted on the chassis.

Apart from using a lay-out similar to the original (but not necessarily identical) and from taking the few precautions we have mentioned, there is nothing difficult about the wiring. A feature of the circuit is the extremely low impedance that exists almost everywhere except in the feedback network of the oscillator amplifier, where the impedance is unusually high and necessitates the precautions that have been outlined. In low-impedance circuits, the wiring does not actually need to be as carefully done as usual, because there is less chance of stray pick-up of unwanted signals through unintentional capacity or inductive coupling. Because of this, quite long leads can be tolerated in some parts of the circuit, so that we do not need to worry about the fact that large coupling condensers make it impossible to get leads as short as they would otherwise be.

SETTING UP THE INSTRUMENT

Once the oscillator has been built, there is still the question of making it work properly, and, although this is not at all difficult, especially if the following tips are taken to heart, the circuit is not one that will perform at first switching on until after the necessary adjustments have been made.

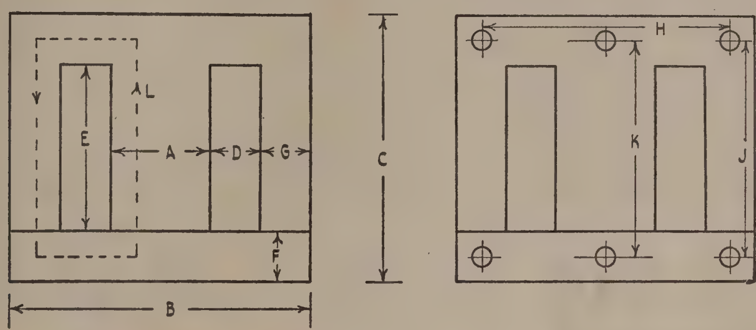
The first important thing that affects the operation of the oscillator section is the choice of the resistors which determine the frequency in conjunction with the variable condenser gang. The three pairs of resistors have values of 10 meg., 1 meg., and 100k. respectively, and by far the most important thing is that they should be accurately matched pairs. Now, this is not to say that the thing will not work if the pairs are not well matched, but we should emphasize that the real success, as judged by ease of operation, with minimum adjustment of the oscillation control, is largely dependent on accurate matching of the condenser gang sections and the pairs of resistors. The former are outside our control, except that we must buy a gang condenser of a reputable make. In any case, the sections of the ordinary gangs used in receivers are matched to a remarkable degree of precision, and this is not likely to be a source of

trouble. We, however, must make ourselves responsible for matching the pairs of resistors. It is a good plan to complete the whole instrument, except for the frequency-determining resistors and perhaps the output attenuator, which can be added later. The resistors can easily be mounted on the range switch after everything else has been completed, and if suitable pairs are first obtained they can be wired in and forgotten, so that no replacements will be needed.

(To be continued.)

BEACON Technical Topics No. 19

LAMINATIONS used by BEACON RADIO LIMITED



Dimnsions Lamination	Tongue	Overall		Window		Limbs		Mounting Centres			Mag. Path
	A	B	C	D	E	F	G	H	J	K	L
M.E.A. 36	7/16 in.	1 27/32 in.	1½ in.	29/64 in.	1 in.	¼ in.	¼ in.	..	..	..	3.87 in.
00	9/16 in.	1 11/16 in.	1 13/32 in.	9/32 in.	27/32 in.	9/32 in.	9/32 in.	..	..	..	3.38 in.
0	5/8 in.	1 7/8 in.	1 9/16 in.	5/16 in.	15/16 in.	5/16 in.	5/16 in.	..	..	..	3.75 in.
0b	5/8 in.	1 7/8 in.	..	5/16 in.	1 9/32 in.		5/16 in.	..	..	..	..
1	¾ in.	2¼ in	1 7/8 in.	3/8 in.	1 1/8 in.	3/8 in.	3/8 in.	..	..	..	4.5 in.
2	7/8 in.	2 5/8 in.	2 3/16 in.	7/16 in.	1 5/16 in.	7/16 in.	7/16 in.	2 3/16 in.	1¾ in.	..	5.26 in.
3	1 in.	3 in.	2½ in.	½ in.	1½ in.	½ in.	½ in.	2½ in.	2 in.	..	6 in.
4	1 in.	3¼ in.	2 7/8 in.	5/8 in.	1 5/8 in.	5/8 in.	½ in.	2 5/8 in.	2¼ in.	..	6.75 in.
5	1¼ in.	3¾ in.	3 1/8 in.	5/8 in.	1 7/8 in.	5/8 in.	5/8 in.	..	..	2 7/8 in.	7.5 in.
6	1¼ in.	4 in.	3½ in.	¾ in.	2 in.	¾ in.	5/8 in.	3¼ in.	2¾ in.	2¾ in	8.25 in.
7	..	..	..	..	..	..	..	..	..	..	..
M.E.A. 120	1½ in.	4½ in.	3¾ in.	¾ in.	2¼ in.	¾ in.	¾ in.	..	..	3 3/8 in.	9 in.
Large F	1½ in.	5 in.	3 5/8 in.	1 in.	2 1/8 in.	¾ in.	¾ in.	4¼ in.	2 7/8 in.	2 7/8 in.	9.25 in.
8	1¾ in.	6 in.	5¼ in.	1¼ in.	3 in.	1 1/8 in.	7/8 in.	..	..	..	12.5 in.
9	..	..	..	..	..	..	..	..	..	..	..
10	2 in.	7 in.	6½ in.	1½ in.	4½ in.	1 in.	1 in.	..	..	..	16 in.
11	2½ in.	8½ in.	7¼ in.	1¾ in.	4¾ in.	1¼ in.	1¼ in.	7¼ in.	6 in.	..	18 in.
12	75 mm.	220 mm.	170 mm.	35 mm.	95 mm.	37.5 mm.	37.5 mm.	..	..	..	41 cm.

NOTE.—Mounting holes may be absent, two, four, or six in number, depending upon lamination size.

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The PHILIPS Experimenter

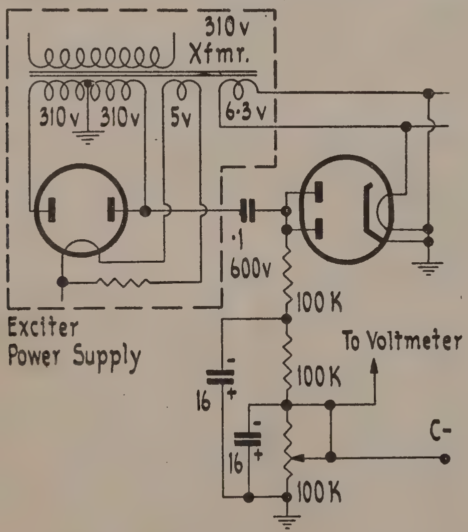
No. 27: SETTING UP AND ADJUSTING THE SEQUENCE SWITCHING RELAYS OF THE PHILIPS 100-WATT TRANSMITTER

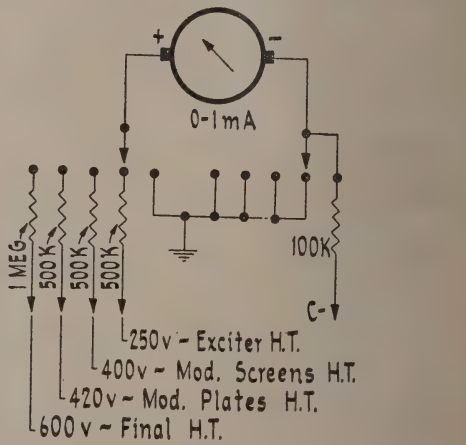
In our description last month of the sequence switching that has been incorporated in the power supply system, we did not have space to describe the action of the overload relay. This relay has the job of turning off the H.T. from the final amplifier in the event that an accidental overload occurs. This could happen through failure of any components of the final amplifier circuit, resulting in much more than the normal load current being drawn from the final's power supply. Also, the overload relay will operate if a fault in the aerial system results in gross de-tuning of the final's plate circuit, or during tuning up, should a condition be arrived at in which the final draws too much plate current. In the original transmitter, the final, it will be remembered, draws 150 ma. plate current and 20 ma. of screen current when fully loaded. The overload relay was adjusted so that it pulled in with a total current through the coil of approximately 220 ma. This is 50 ma. more than the normal full load on the power supply. Due to the manner in which the relay was adjusted, the action was very positive, but at the same time, there was no danger at all of things turning themselves off under normal modulation conditions. However, it was found that a momentary surge caused by bumping the microphone would cause the relay to operate if the bump was bad enough. This is a useful feature, because it helps to protect the modulation equipment from a recurrence of such peaks, and at the same time to prevent more than one loud noise from such an accident, from being broadcast to the world at large.

HOW THE OVERLOAD RELAY WORKS

Referring to the circuit diagram in last month's Experimenter, it will be seen that the output current from the final's power supply flows at all times through the coil of the relay, via a pair of its own contacts, which are *closed* in the normal, or non-operated condition of the relay. There is also a pair of normally open contacts, and one of these is wired in parallel with one of the normally closed pair—to be precise, to the one which connects to the supply. The free contact of the normally open pair is connected to the dummy load of 3000 ohms. During normal running, this dummy load is entirely disconnected from the rest of the circuit by the normally open contacts, and so passes no current. Now the tension on the relay spring is such that with the normal 170 ma. passing through the relay coil, it stays open, but closes when the current rises to 220 ma.

A further necessary feature about the overload relay's contacts is that the normally open pair must close a fraction of a second before the other pair opens. This can be brought about by suitably bending the contact leaves, and the fixed contacts, because on the ZC1 aerial relay which was used for this purpose, there is a great deal of latitude about the setting of the contacts, owing to the long springy leaves, and the spring-loaded fixed contacts. Assuming, then, that the relay has been suitably doctored so that the open contacts close before the others open, it is seen that when the armature starts to move, under the influence of an overload current, there must be a brief moment during which the dummy load resistor is connected to the power supply simultaneously with the final amplifier. Thus, there is a momentary current of about 400 ma. passed through the relay coil, and this kicks the relay in very smartly indeed. It is because of this feature that the operation is so positive, the current drawn by the dummy load assisting the overload current to close the relay. However, the real purpose of the dummy load is quite different. It is to prevent the relay from acting as a buzzer, which it would certainly do if, once it has disconnected the final, no more current passed through the coil. The same trick could have been done by a latching relay, but such





Left: Fig. 1.—Modulator Bias Supply.

Right: Fig. 2.—Power Supply Volt Meter Circuit.

things are not readily come by. In any event, the present system has the further advantage of keeping a normal load on the power supply after the final has been disconnected.

In series with the dummy load is a push-button switch, whose contacts are normally closed, completing the dummy load circuit. This switch acts as a re-set button, and enables normal operation to be restored immediately if the overload relay has been brought in, not by a genuine fault, but by maladjustment during tuning up, or some similar cause. When the button is pressed, the current through the dummy load, and therefore through the relay coil, is interrupted, allowing the relay to open again and to restore the normal connections. If a real fault has caused the overload relay to come in, pressing the re-set button will do no harm, because as soon as it is released, the relay will operate again, in which case the final H.T. should be switched off and the fault tracked down.

In setting the overload relay spring and contacts so that it comes in at the right value of current, the final plate current meter can be used to see what current causes the relay to operate, and overload conditions can best be simulated by allowing the transmitter to supply power to a dummy aerial, properly tuned up. Then, the overload is simulated simply by increasing the aerial coupling, causing the final to draw more current, and, incidentally, to give more power output, too! There is no difficulty, if the load is non-reactive, in getting the final up to a plate current of 250 ma., an input of 150 watts! Alternatively, with no dummy aerial, the overload condition can be simulated by de-tuning the final until the plate current rises sufficiently. This system should be used only with care, however, because it leads to excess plate dissipation, whereas the first method does not.

INSTALLATION OF THE GRID CURRENT RELAY

The grid current relay, Rl_2, used in the prototype was a Guardian, with a 10,000-ohm coil. However, constructors may not be able to get a relay that is exactly similar to this one, so we will describe a general procedure for adjusting the grid current of the final amplifier so that the relay used comes into operation at a suitable value of grid current.

The actual grid current of the QQEO6/40 is 10 to 12 ma., but we need the relay to come in at a rather smaller value than this, for reasons which will appear. A suitable figure is 5 or 6ma., but if quite so sensitive a relay cannot be obtained, it will be necessary to put up with a higher figure However, with a working grid current of 12 ma., it would be perfectly satisfactory if the relay pulled in at, say, 8ma. At this point we should explain that the resistance of the relay coil is not important, as long as the sensitivity is great enough. For example, the required value of grid leak for the final is 6000 ohms. If a sensitive enough relay were available which had a smaller resistance than this, it would only be necessary to place the relay in series with enough resistance to make the total up to 6000 ohms. The combination of relay coil and series resistor would then replace the simple grid leak resistor shown in the original

(Continued on page 44.)

RADEL PORTABLE FIVE

(Continued from page 8.)

it is virtually impossible to alter the inductance, and a big advantage of the plastic variety is that turns may just be peeled off until the right inductance is obtained. This is because these loops are self-supporting, the turns being "flowed" together by means of heat during the making, so that the wire insulation itself supports the structure of the loop. It is not generally realized that placing the loop aerial of a portable near to the metal chassis causes a substantial reduction in its inductance. Because of this, the set will not align to best advantage unless the loop has the correct inductance AFTER IT IS PLACED IN ITS FINAL POSITION. Since ordinary loops must be adjusted during manufacture to an inductance of some average value, it stands to reason that a portable built with one may not necessarily be as sensitive over the whole dial as it could be with a loop in perfect alignment.

In order to avail ourselves of the facility provided by the variable loop, all we have to do is to align the set in the ordinary way as far as the grid of the mixer stage. That is to say, the oscillator padder and trimmer and the mixer grid trimmer are adjusted in the usual way. In doing this, the signal generator can be fed into the grid of the R.F. stage, isolating the sig. gen. from the mixer circuit. At this stage, all that is left to adjust is the aerial circuit. In a normal set, this would mean the aerial trimmer only, but here we have the loop inductance as well.

Let us assume, therefore, that the set is completely aligned except for the aerial circuit. Here, it is not possible to feed the signal generator directly to the set, as doing so would upset the tuning of the aerial circuit. The best thing to do, therefore, is to connect a single-turn loop of wire between output and earth terminals of the signal generator and to use space coupling to the set by placing the signal generator loop about a foot away from the receiver loop. The set is closed up so that the loop is in the position it will occupy in practice, and the signal generator is tuned to 1400 kc/sec.—the high-frequency alignment point. The signal is tuned in with the set's main dial, and then the aerial trimmer is tuned for maximum response. Now, the signal generator is set to 600 kc/sec., and this is tuned in with the set's main dial. At this frequency, the aerial circuit will be out of adjustment, owing to the inductance of the loop being incorrect. Therefore, the aerial trimmer is re-adjusted for maximum response, AND THE DIRECTION OF MOVEMENT TO GIVE THIS IS NOTED. If, as will certainly be the case, the inductance of the loop is too great, the trimmer will have to be **reduced** in capacity to bring the circuit into tune. This is a positive indication that the loop inductance is too large, and that turns should be taken off. The next step is thus to peel off, say, a quarter of a turn of the loop and put the lid back on the set.

The aerial trimmer is then re-adjusted at 1400 kc/sec., as before, and the test carried out at 600 kc/sec. to see whether it is still necessary to take off some turns. This process is repeated until it is

(Concluded on page 48.)

TUBE DATA: The 3D6/1299

A USEFUL VALVE AVAILABLE IN WELLINGTON

Quite recently a very useful and unusual type of battery valve has been seen in Wellington and can be bought at at least one retailer's. It is the 3D6/1299. Unfortunately, there will be no more of them after present stocks are exhausted, because they are of war-surplus origin and American manufacture. However, while they last, we thought readers would be glad to know a little more about them. We ourselves only came across the data on them by accident, and their characteristics are such that they should appeal to amateur transmitters and home constructors in no small measure.

The 3D6 is a loctal-based 1.4 or 2.8 volt filament type. Its main characteristics are similar to those of the 3Q5, which is an audio power pentode. However, the 3D6 goes a lot farther than this, as it is specially designed for use as a Class C R.F. amplifier at frequencies up to 200 mc/sec. For example, at 20 mc/sec., it can turn out 2 watts of R.F., and at 200 mc/sec it is capable of an output of 0.5 watts, with corresponding outputs at intermediate frequencies. It appears to be ideally suited to portable transmitting equipment for all bands up to 144 mc/sec.—the highest amateur band that comes within its ratings.

AN EXCELLENT AUDIO AMPLIFIER

As an audio amplifier, the 3D6 is noteworthy in that it is the highest-rated power valve in the 1.4 volt filament series. It will stand screen voltages up to 135 volts in this application, and plate voltages up to 180. With these voltages it can put out 0.9 watts of audio, which is rather a feat for so small a valve. Of course, this does not make it adaptable to the smaller portable sets, because at high voltages like this the current would be excessive, as well as the voltage. However, it brings up some interesting possibilities for use where more than the usual miniature batteries can be carried. For example, it could be made the basis of an excellent portable electric gramophone. A pair of these valves would give a little more than 2 watts if the full H.T. voltage could be supplied, and even at lower voltages very useful power outputs could be obtained.

This valve would make it worth while to build a battery-operated amplifier and speaker into a portable gramophone case, the acoustic part being dispensed with in favour of electrical reproduction. There would probably be room for the amplifier and batteries in the spare space under the motor board, and the speaker could perhaps be housed in the lid, which would be used as a baffle. To attempt such a thing with miniature valves would not be very profitable, because it would be difficult to get enough power output to make it worth while.

CHARACTERISTICS

Physical Specifications:

Base	Lock-in 8-pin
Bulb	T9
Maximum overall length	2 25/32 in.
Maximum seated height	2¼ in.
Mounting position	Any

Ratings:

	Series	Parallel
Maximum filament voltage D.C.	*3.5	*1.75 volts
Minimum filament voltage D.C.	2.8	1.40 volts
Filament current	0.110	0.220 amp.
Maximum plate voltage	180	180 volts
Maximum screen voltage	135	135 volts
Maximum cathode current†	30	30 ma.
Maximum plate dissipation	4.5	4.5 watts
Maximum screen dissipation	0.9	0.9 watt

*For parallel operation, connect pins No. 1 and No. 8 to positive voltage supply, and pin No. 7 to negative voltage supply. For series operation, connect pin No. 1 to positive and pin No. 8 to negative.

†When series operated, a shunting resistor should be connected across the section of filament between pins No. 7 and No. 8 of sufficient value to bypass any cathode current in excess of the maximum per section. If other tubes in a series filament arrangement contribute to the filament current of Type 3D6, an additional shunting resistor may be required between pins No. 1 and No. 8.

Direct Interelectrode Capacitances	Note 1	Note 2
Control grid to plate	0.30	0.30 $\mu\mu$f.
Input	7.5	7.5 $\mu\mu$f.
Output	5.5	6.5 $\mu\mu$f.

Note 1.—With no external shield (Pin No. 5 connected to filament centre tap).

Note 2.—With 1 5/16 in. diameter shield (RMA Std. M8-308(connected to negative filament (Pin No. 5 connected to filament centre tap).

Typical Operation:

A-F Power Amplifier Class A_1

Filament voltage	1.4	1.4	1.4 volts
Filament current	0.220	0.220	0.220 amp.
Plate voltage	90	135	150 volts
Screen voltage	90	90	90 volts
Grid voltage	—4.5	—4.5	—4.5 volts
Peak A-F signal voltage	4.5	4.5	4.5 volts
Plate current zero sig.	9.5	9.8	9.9 ma.
Plate current max. sig.	8.5	9.8	10.2 ma.
Screen current zero sig.	1.6	1.2	1.0 ma.
Screen current max. sig.	3.2	2.0	1.8 ma.
Mutual conductance	2400	2400	2400 μmhos
Load resistance	8000	1200	1400 ohms
Total distortion	5	5	5 per cent.
Power output	270	500	600 mw.

R-F Power Amplifier Class C (50 mc.)

Filament voltage D.C.	1.4 volts
Plate voltage	150 volts
Screen voltage	135 volts
Grid voltage (approximately)†	—20 volts
Plate current	23.0 ma.
Screen current	6.0 ma.
Grid current	1.0 ma.
Total D.C. cathode current	30 ma. max.
Peak R-F grid voltage	1.5 watts
R-F power input	55 volts
R-F power output	1.4 watts

†May be obtained from a fixed source, or by use of a suitable grid resistor.

Base Connections:

The base connections for the 3D6 are as follows:—

Pin No. 1	Filament
Pin No. 2	Plate
Pin No. 3	Screen-grid
Pin No. 4	N.C.
Pin No. 5	N.C.
Pin No. 6	Control grid
Pin No. 7	Filament centre-tap
Pin No. 8	Filament

THE N.Z. RADIO TRADERS' FEDERATION —A MESSAGE FROM THE PRESIDENT

DE-CONTROL OF PRICES WITHIN THE RADIO AND ELECTRONIC INDUSTRY

Members will have already been apprised of the statement made by the Minister of Industries and Commerce which was published on 2nd November last announcing the de-control of prices within the radio and electronic industry. This notification has been formally promulgated in the "New Zealand Gazette," dated 3rd November, 1949, and is operative from that date. The effect of this notice is to revoke all price orders and approvals issued prior to 3rd November, 1949, in respect of goods and services within the industry, and frees all members from the necessity of applying for approved price structures for all radio and electronic goods, together with all parts and devices related thereto.

In simple terms, the effect of the "Gazette" notice is that the industry is now completely free of price control, and previous prices authorized by the Price Control Division no longer apply. This announcement is the culmination of the work of your sub-committee duly appointed to handle this matter with the Price Control Division and the Price Tribunal, acting in full consultation with the radio section of the Manufacturers' Federation. There is no doubt widespread satisfaction and gratitude in the trade in regard to the outcome of these negotiations, which serves to highlight the results which can be achieved by concerted action on behalf of the radio trade. Here, again, is proof of the major advantages accruing from membership of your Radio Traders' Association, and it is emphasized that the need for increased membership of the local association has not passed, and, indeed, our efforts must be redoubled in a strong endeavour to double and even treble membership of the local associations so that the major body may speak with the united voice of the industry. We should perhaps take as our maxim, "Strength in peace is a major prerequisite to strength in war."

Although all members will be gratified with the freedom now given, there is, nevertheless, a strong note of caution to be sounded. Your federation has stated to the Price Tribunal that it is their opinion that there would be no widespread increases in prices as a result of de-control of the industry and that the federation would view with extreme disfavour the action of any individual member indiscriminately increasing prices. It was felt by your executive that competition would be a sufficiently controlling factor in maintaining prices at least at their present level, and that in the isolated cases where competition does not seriously exist the inherent good sense and fair play of the manufacturer and trader alike would prevail. The radio section of the Manufacturers' Federation has given a similar undertaking to the Price Tribunal.

The attention of members is drawn to the fact that if violations occur the Price Tribunal has statutory power to re-impose control of the industry at 24 hours' notice. Furthermore, the radio industry is now in a position of trust, and the reactions within the industry—the first major industry to be de-controlled—will be taken as a yardstick in assessing the reactions of traders within other industries when the latter should come up for consideration in respect of de-control of prices.

The appreciation of members is expressed to the

(Continued on page 48.)

OUR GOSSIP COLUMN

"The Relax" is the title appearing over the stage of a theatrette recently installed at the N.E.E.Co. factory, Kaiwarra. A private screening for the benefit of a "Radio and Electronics" representative proved nothing lacking for enjoyable cinema entertainment, as acoustic properties are well cared for and the sound reproduction from the B.T.H. 16 mm. projector leaves nothing more to be desired.

The ingenuity shown by members of the staff, whose combined efforts produced the theatrette from surplus materials, packing-cases, etc., is commendable. Fancy trimmings, attractive murals, and false windows, together with air-conditioning, give the whole a restful and realistic setting well suited for lunch-hour and special screenings.

* * *

L. A. Chaston, Ltd., Wellington, announces a recent alteration in the name of its retail shop from "Radio and Electrical Exchange" to "Cambridge Home Electrical Supplies." The premises have been altered and modernized, facilitating a better display of a splendid range of radio and electrical components and appli-

* * *

ances.

Branch managers Dave Reid, Ken Schollum, and Norm Chiswell, of Swan Electric Co., Ltd., met in Wellington for a conference during November.

* * *

A.W.V. Pty., Ltd., announces that preparation has commenced of the fourth edition of the "Radiotron Designers' Handbook," which is expected to go to press about June, 1950. Deliveries may be anticipated some months later.

* * *

After a short spell in hospital for a minor operation, P. C. Collier is now back on the job, looking pretty fit.

* * *

Wellington this month will be the location of a branch managers' conference of Turnbull & Jones, Ltd.

* * *

On view at the Cambridge Home Electrical Supplies, Wellington, recently, was a "Signal" camera portable, in an attractive dark-red plastic case. This late-model American portable measures only 6 in. x $3\frac{1}{2}$ in. x 3 in., and is switched on by the now popular method of opening the lid. The batteries used are a 455 B supply and a 950 A supply. Performance compares favourably with standard size local personal portables, except that output and quality are limited with the 2 in. speaker.

* * *

Recent visitors to Wellington have included George Wooller (Auckland), Gordon Vickery (Otorohanga), and George Benson (Auckland).

Walter Green has recently completed an extensive tour of the Hawke's Bay and Waikato areas.

Jack Wyness has taken unto himself a seaside section. Now for some really hard graft on Saturdays, Jack!

* * *

Grover Electrical Co., Ltd., Wellington, announces its removal to larger and brighter premises at No. 3 Vivian Street (next door to National Carbon Pty., Ltd.). It is first-floor accommodation, with easy access to cart dock and lift. Good office space will make for excellent administration, and, while the

new showroom is not large, it is ample for demonstration purposes, and visiting dealers will appreciate this additional space after the cramped conditions of the old premises.

Radio and Electrical Services, Auckland, propose reorganization of their laboratory and premises at Newton, says Bill Barker, managing director. This has been necessitated by the rapid development of the field of sound business. Here is Charles Lippiatt, chief technician, in a corner of the lab. at Newton, working out a complex problem.

ANOTHER LINK IN THE NEECO CHAIN

Advice that the National Electrical and Engineering Co., Ltd., has recently opened an Invercargill sub-branch is further evidence of the steady growth of the Neeco organization.

Started jointly by Messrs. Nelson Jones and the late E. W. Ackland at Dunedin in 1906, today the company has flourishing branches in the four main centres, and others at Hamilton, Hastings, Wanganui, and now Invercargill.

Agencies held by "National Electric" include such famous names as the British Thomson-Houston Co., Ltd., of Rugby, England; General Electric Co. (Inc.), U.S.A. (and Affiliates); Canadian General Electric Co., Ltd.; Australian General Electric Co. Pty., Ltd.; Amalgamated Wireless (A'asia), Ltd.; Amalgamated Wireless Valve Co. Pty., Ltd., Australia; Automatic Coil Winder and Electrical Equipment Co., Ltd.; International Refrigerator Company, Ltd., London, England; and Burgess Products Co., Ltd., Hinckley, England.

"RADIO AND ELECTRONICS"

Back and current numbers of "Radio and Electronics" may be obtained from—

Te Aro Book Depot, Courtenay Place, Wellington.
S.O.S. Radio, Ltd., 283 Queen Street, Auckland.
S.O.S. Radio, Ltd., 1 Ward Street, Hamilton.
Tricity House, 209 Manchester St., Christchurch.
Ken's Newsagency, 133–135 Stuart St., Dunedin.

A SIMPLE STROBOSCOPIC LAMP

(Continued from page 14.)

In our initial explanation, we purposely omitted to mention these multiple images so as not to complicate the issue, but it is quite easy to see how they come about. For example, if the flashes are taking place at just twice the revolution rate, two spots will appear, diametrically opposite each other; for, in this case, the disc has turned one-half a revolution when a further flash occurs, and we are shown the spot at two positions during its complete travel. Also, if the flashing rate is three or four times the revolution rate, we will see the spot three or four times every revolution. The important question is, how do we know when the right stationary picture is presented? It is clearly incorrect when two or more spots are showing, but unfortunately there are other circumstances under which a single spot can show and yet the lamp and the rotations are not at the same rate. This situation arises when the flashing frequency is a SUB-multiple of the rate of rotation. Suppose, for example, that the lamp flashes once in every **two** revolutions of the disc. In this case, only one spot will be seen. Similarly, too, when the lamp is at one-third or one-fourth the rate of revolution. Luckily, however, there is a simple rule whereby these ambiguities can be resolved. It is to start, as above, with the lamp rate definitely **faster** than the movement to be observed. Then, on reducing the lamp frequency, we can see the picture pass through the multiple patterns in succession. After the two-spot picture is seen, the rate is reduced carefully, whereupon the first single picture will appear. **This is the correct one.**

It may now be pointed out that when the lamp rate is too slow, it is also possible to find multiple pictures. These happen when fractional relationships occur between the two rates in which we are interested, but they can be disregarded in practice, because they are hard to find and the pattern is quite blurred compared with the main ones. One thing which helps to distinguish the correct single pattern is that this one is sharper than the wrong ones. This is because at the lower flashing rates, the flash is of longer duration, so that the spot travels farther while the flash is on. After a little practice it is quite easy to tell whether the pattern is the correct one or not, so that there is little need to worry about correct identification.

MODIFYING THE LAMP

It was mentioned above that the 5-watt neon lamp must be modified in order to make it suitable for the circuit. The modification consists simply in taking off the brass base, taking out the wire-wound resistor, and soldering the lamp leads into a new base, taken from an old lamp. It is not usually possible to remove the base without breaking it if the bulb is to be intact, so that the best way is to bore a small hole in the brass part of the base, into which the nose of a pair of side-cutters can be inserted. Then the base can be cut round and the thin brass torn so that it comes off the glass. Of course, the leads should be unsoldered before the removal operation, because if they are shortened it may not be possible to insert them in the new base.

USE OF A REFLECTOR

In order to get a worth-while increase in the amount of light available from the lamp, it is a good plan to buy a reflector such as are sold for photographic purposes. The ones that are used for photoflood lamps are most satisfactory, as they totally enclose the bulb on all sides (except one) and very little light is lost. If the instrument is to be made up permanently, it is a good plan to mount the reflector on a goose-neck stand with a heavy base so that the lamp can be set in any convenient position quite easily.

USING THE STROBOSCOPE FOR MEASUREMENTS

From what has been said, it will be clear that if the stroboscope is to be used not only to observe, but also to measure speed of revolution, the multivibrator frequency control will have to be calibrated. If access can be had to an accurate audio oscillator and a 'scope, this is a very easy matter. The 'scope's time-base is set running and the Y-plates are fed from the plate or grid of V_3. The output pulses illustrated above can then be seen on the screen. The time-base is then adjusted so that only one pulse is seen, indicating that time-base and pulse are at the same rate. Then the audio oscillator is fed to the Y-plate instead of the pulse, and, without touching the time-base frequency control, the oscilloscope is adjusted to a frequency at which only one cycle can be seen on the time-base. We have then adjusted the oscillator to the same rate as the multivibrator. If a pointer and scale are attached to the latter's frequency control knob, the frequency in c/sec. can now be marked against the pointer setting. Even more useful is to multiply the frequency of the oscillator by 60 and call the answer R.P.M. The whole scale can be calibrated in this way for both ranges of the frequency switch, and, with a top frequency of 200 c/sec. or so, speeds up to 12,000 r.p.m. will be on the scale.

(Continued on page 48.)

Acoustics and the Reproduction of Sound

By J. N. NORMAN, Grad.I.E.E.

The effect of the acoustics of the small room in which sound from the radio or pick-up is reproduced in the average home is a subject concerning which not a great deal has been written. The following notes are written with the idea of interesting high-fidelity enthusiasts in some of the problems involved. It must be stressed at the outset that these considerations do only apply to high-fidelity reproduction and have very little application to the type of reproduction usually obtained from the small table model receiver. While the conclusions reached may not be too encouraging, the subject is one of interest in that the limitations to the reproduction of, say, a full symphony orchestra in a room having a volume of the order of 1500 cubic feet should be fully appreciated.

Before going any further, it is necessary to understand something of the mechanism of the absorption of sound. Sound waves consist of longitudinal vibrations of the molecules of the medium through which the sound wave is travelling, usually air. Absorption of the sound energy takes place when the energy of motion of the molecules is given up in a change to some other form of energy, such as heat. This absorption can take place in several different ways as the sound waves strike the surface of the material. With porous or fibrous materials, the energy is dissipated in the friction which takes place between the material and the moving particles of air. With compressible materials, it is dissipated by the internal friction associated with the compression of the material and with vibrating structures such as the walls, floor, and ceiling of a room, the energy is absorbed by producing and maintaining the vibrations in the structure.

If a source of sound, for practical purposes an audio oscillator, amplifier, and speaker, or an organ pipe, is excited in a room, it will be found that the average density of the sound energy in the room will increase until a steady state is reached in which the energy is evenly distributed throughout the room, and the rate at which the sound energy is being produced by the source is equal to the loss of energy through absorption at and transmission through the walls.

If the sound source is stopped suddenly, the sound itself will be heard to die away gradually, the average sound energy density decreasing as the sound is absorbed. This growth and decay of sound energy is very similar to the familiar charging and discharging of a condenser through a resistance, and if curves were plotted of the amplitude of the sound in the room as it built up and decayed, they would be seen to be of the same type as the curves for the voltage across a condenser as it was charged and discharged.

This gradual decaying of the sound energy is known as "reverberation," and one of the most important factors in the study of the acoustics of a room is the "reverberation time." This may be defined as the time taken for the amplitude of the sound in the room to decay to one-millionth of its initial value—that is, a decrease of 60 decibels in the amplitude after the source is stopped.

The importance of the reverberation time will be apparent when the nature of the sounds heard in speech and music is considered. These sounds, in reality, consist of series of disconnected syllables which are separated by definite periods of silence. If, therefore, the reverberation time is too long, sound from a preceding syllable or phrase will not have died away before the following syllable is sounded, and in extreme cases severe lack of intelligibility can result. A short reverberation time will give better intelligibility to speech, but music may sound dead and uninteresting. The answer to what is the most desirable reverberation time for a given purpose is a difficult one to which no fixed quantity may be given, as it is dependent to a large extent on personal taste. It must obviously be different for speech and music, and even for different types of music. Organ and choral music is found to be more pleasing with a relatively long reverberation time, solo instruments usually require a shorter time than a full orchestra, and so on.

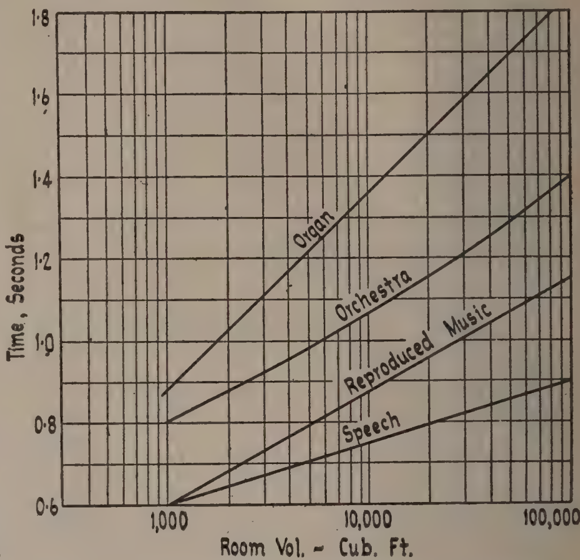


Fig. 1.—Best reverberation time for rooms of various sizes and for different types of sound.

Subjective tests on listeners have resulted in a standard set of curves showing optimum reverberation times for various types of sound and various conditions of listening, and these curves are used in the design of the acoustical treatment for broadcasting and recording studios. A set of such curves is shown in Fig. 1. It may be said as a general rule that the reverberation time of a room to be used for the reproduction of sound should be quite considerably less than that of the room in which the sound is originally produced, as this sound will, of course, contain the reverberation of the original. It will be seen from Fig. 1 that the optimum reverberation time for a room of 1500 cubic feet capacity is approximately 0.65 seconds at 500 c.p.s. for the reproduction of music. Experience has shown that the optimum time alters with frequency, other factors being constant, a rising characteristic at the lower frequencies being desirable.

Fig. 2 gives a curve showing the optimum time as a function of frequency for such a room, the reverberatime at 100 c.p.s. being nearly twice that at 500 c.p.s. It also gives a curve taken from actual measurements in a room of this capacity having the normal type of

construction and normal furnishings. It will be seen that the measured curve departs considerably from the optimum, and we shall have something to say about this in a few moments.

The reverberation time of a room is controlled by the amount of absorption present—that is, by the absorption coefficients of the various materials in the room, and rooms can be designed to have practically any desired reverberation characteristic. Reverting to

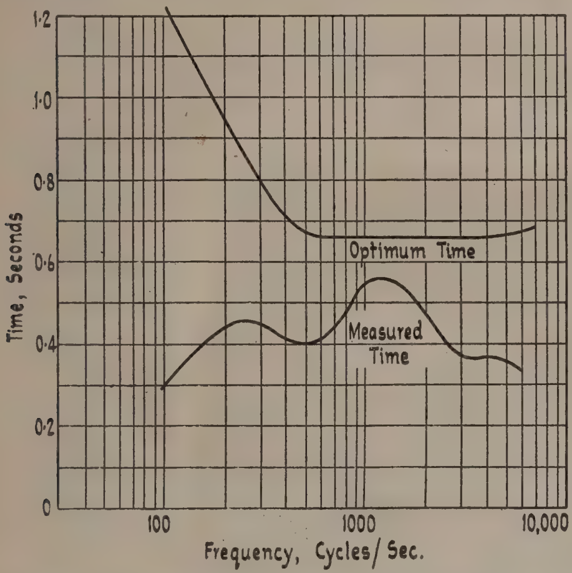


Fig. 2.—Curves showing the optimum reverberation time for a room of 1500 cubic feet, together with a curve measured on an actual room of this size.

our remarks on the manner in which different materials absorp sound, let us take the first case—namely, absorption by porous and fibrous materials in which the energy of motion of the sound wave is dissipated in friction between the moving air and the small instertices of the material. It will be seen that the dissipation of energy is greatest for the higher audio frequencies. This is due to the fact that the velocity of motion of the individual particles in the air making up the sound wave is proportional to and increases with the frequency of the sound, and the rate of dissipation of energy is therefore greater. The fibrous insulating wall-board which is used extensively these days is a typical example, and when measurements of the coefficients of absorption of this material are made it is found that the coefficient does increase with frequency. Typical absorption coefficient curves of common materials are shown in Fig. 3.

The curves show a general decrease in the absorption of these materials with decreasing frequency, and it might be assumed from them that a result approaching the optimum curve of Fig. 2 would be comparatively easily obtained. Practical results are, however, usually quite different, as can be seen in the curve of Fig. 2 drawn from actual measurements. It is obvious that there is a vast discrepancy between the low-frequency reverberation which would be expected from the curves of Fig. 3 and those actually obtained. In practice, this will show up as a loss in low-frequency response when listening in the room. The cause is not at first obvious until we consider the physical properties of the walls, floor, and ceiling of the room, which play an important part in the absorption of the lower audio frequencies. As stated earlier, sound energy is dissipated whenever these structural members are set into vibration, the energy required to produce and maintain the vibrations being derived from the energy inherent in the sound wave. It is difficult to appreciate that the sound energy radiating from the average domestic speaker will vibrate such a massive structure as a 9 in. brick wall, but this has been proven by practical experiment and measurement. The structural elements of a building have natural resonances at low frequencies, and at the resonant frequencies may absorb many times the energy absorbed at other frequencies.

It may be thought that this loss in low-frequency reverberation can be overcome by increasing the low-frequency response of the reproducing system, but unfortunately such a correction is not the complete answer. Reverberation adds musical colouration to the sound by virtue of the decaying characteristic, and this colouration is not added with a simple increase in amplitude of the direct sound. Subjective tests on listeners, each of the test conditions having one of the

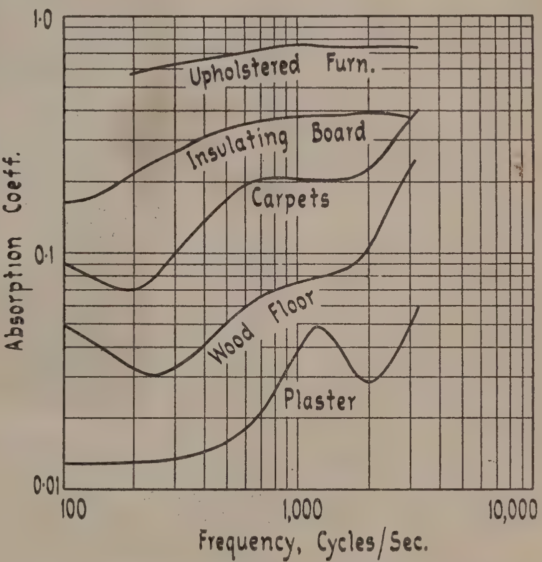


Fig. 3.—Curves showing the absorption co-efficient for a number of constructional materials at audio frequencies.

characteristics of Fig. 3 bear this theory out.

The question of structural and room resonances introduces some interesting points in the general theory of reproduction in small rooms, and one of these is the study of forced vibrations and free resonant vibrations. Let us consider the simple case of a resonant body in the room capable of radiating sound such as, for example, a large low-frequency bell. Admittedly such an object is not likely to be found there, but it is an ideal subject to take for purposes of discussion. If our organ pipe or audio oscillator were to sound a continuous note at the resonant frequency of the bell, one would find that the bell would store up energy and would continue to sound after the sound source had been stopped. the amplitude decaying as the

stored-up energy was dissipated in maintaining the vibrations in the bell. The result, to the ear, would be indistinguishable from true reverberation, and the room would have apparently an increased reverberation time at that frequency. Now, if the frequency of the sound source differed by a small amount from the resonant frequency of the bell, it would again store up energy, not so much this time, and would continue to radiate energy after the source was stopped. In this case, however, there is a most important difference. The frequency at which the energy was radiated by the bell after cessation of the sound source would be found to be the resonant frequency of the bell. In other words, the bell is given a forced vibration at the frequency of the sound source until the source is stopped, at which time an immediate change takes place in the frequency of the sound radiated by the bell, this becoming a free vibration at the resonant frequency of the bell.

An electrical analogy was mentioned earlier between the charging of a condenser through a resistance and the building-up and decaying of sound energy in a room. An exact analogy can also be made in the above case between tuned electrical circuits excited off their resonant frequency and the vibrations of the bell. Oscillograms have been taken of the effect in the electrical case which prove the theory indisputably. A practical example of the acoustical case is found in the low-frequency response from receivers which have the speaker in a cabinet having a pronounced resonance. The reader will have noticed that in such receivers the bass notes as reproduced appear to have the same pitch over quite a large part of the musical scale and are prolonged and very "boomy." Likewise, if the walls of a small room are resonant at a relatively high audio frequency, this colouration must take place to the detriment of faithful reproduction.

Another undesirable result may be experienced if the room has a long reverberation time round these frequencies, for then the structure will be set into the natural resonant vibration, while at the same time the sound at the frequency given by the source will be decaying in the course of the normal reverberation, and perceptible beats may be heard between the reverberant and re-radiated sound. In the recognized theory of harmony, the ear will accept as harmonious any complex tone in which the beat frequency is low in comparison with the fundamental, but finds discordant complex tones in which the beats are an appreciable fraction of the fundamental. In our case the beat frequencies are very low, of the order of a few c.p.s., and will therefore not generally be unpleasing, but when they occur they must change the character of the reverberant sound from the original in the concert hall or studio.

It should also be noted that all these effects may be more noticeable on account of the rise in ampli-

tude at the resonant frequency. This will not always be the case, but where the resonant structure—for example, the floor—is mechanically coupled to the speaker, an increase in amplitude of as much as 25 db. may be experienced. This rise in amplitude introduces another factor which does not improve the picture. Any harmonic distortion of the fundamental, and it will be an extremely good system which generates negligible distortion at very low frequencies, will also be increased in amplitude if the harmonic of the signal coincides with a major structural resonance. For instance, with a resonant amplification of 20 db. at 100 c.p.s., a normal 5 per cent. second harmonic distortion of a 50 c.p.s. signal will rise to 50 per cent. in the room, and the character of the original sound will be changed very considerably.

The modern conception of the effect of reverberation is changing from the classical theory which considered the total reverberation time to be the deciding factor, to a realization that impressions of quality are determined largely in the first two hundred-odd milliseconds of the decay period, and that the general theory may not be completely applicable to small rooms in which the dimensions are comparable to the wavelengths of the sounds at low frequencies, and in which the mean free paths of the sound waves are so short that resonance effects come into prominence after a very small period. The mean free path is the average distance which the wave will travel in a room before meeting a boundary surface, and is given by the expression—

$$\text{mean free path} = \frac{4\,V}{S}\ \text{feet, where}$$

V is the volume in cubic feet, and

S is the total surface area in the room in sq. feet.

Speaking in average terms, sound will strike a boundary surface in the room at intervals of $4\,V/c\,S$ seconds, c being the velocity of sound, approximately 1120 feet per second, and part of the sound will be absorbed and part reflected at each impact. As the absorption coefficient varies with frequency, the frequency characteristic of the sound wave will change at each reflection. It is obvious that in a small room there will be many more impacts in the first part of the decay period than in a large room, each influencing the frequency characteristic of the remaining part of the sound wave. The characteristics of the small room therefore impress themselves on the overall acoustic pattern to a much greater extent than a large room.

For high-fidelity reproduction, it is just as important to reproduce the acoustic pattern of the concert hall or studio faithfully as it is to amplify the electrical signal from the microphone free of any type of distortion. The difficulty is, of course, that the acoustics of the reproducing room, particularly with respect to low-frequency reproduction, are controlled entirely by the dimensions and structural materials of the room, and it is neither within the power nor the pocket of the average person to make changes which influence the acoustics to any worth-while extent. Study of the problem results in our having to accept a compromise between good-quality reproduction free from harmonic distortion, which may be obtained from the electrical side of the reproducing system, and absolute faithful reproduction of the original, which must include also the acoustical properties of the reproducer and the reproduction room. In this country, a very high percentage of our listening is through the medium of the disc recording or the radio receiver, and our standard of musical reproduction will become, if it has not already done so to some extent, quite different to that of those people who are more fortunate to be able to base their standards on "live" production. There is no doubt whatever that the small room conditions under which we have to listen will not be changed by the desire for more faithful reproduction of the acoustic pattern, and the time may come when, as we listen to "live" production of music in the concert hall, the impression will be formed that "it doesn't sound right." To put off that day, the best recommendation that can be offered is for us to use our high-fidelity equipment in the largest room in the house, even if this is the basement!

For a most interesting article on this subject, the reader is referred to an article entitled "The Acoustics of Small Rooms," by J. Moir, A.M.I.E.E., published in "Wireless World," November, 1944.

THE NEW ZEALAND ELECTRONICS INSTITUTE (INC.) NEWSLETTER

COUNCIL NEWS

The quarterly meeting of the council was held recently, and, although time was limited to four hours, a considerable volume of business was attended to, including the following matters:—

Establishment of a Journal

This matter has been under consideration for some time, and it is now hoped that finality will be reached with the presentation of a report at the next meeting covering the various alternatives available.

Membership Certificates

Printed proofs of membership certificates have been sighted and authority has been granted for the production of different quantities of certificates covering the various grades of Institute membership.

Financial Support

The support being accorded the Institute by firms interested in electronics is most encouraging, and a donation from Messrs. Collier & Beale, Ltd., of £50 was gratefully received and acknowledged. The president mentioned that other firms would probably be prepared to assist in this respect if approached, and arrangements are in train accordingly.

Institute Insignia

The council of the Institute has for some time been engaged in considering designs for an insignia for reproduction on all Institute stationery and publications. Whilst two or three crests have been submitted and are yet to be considered, an open invitation is extended for all members to submit their ideas in this regard and thus assist the council in its efforts to obtain a suitable and appropriate design.

Examinations

This matter was fully discussed, and the Institute examinations are to be re-instituted early next year. Intending applicants and students should keep in touch with their respective district secretaries for further information.

Institute Membership

The question of those individuals who are not at present eligible for Institute membership on account of the present age-limit for students is under action, and at the next meeting of the council a firm decision will be reached as to whether a special meeting will be called to consider amending the rules to cover those at present unable to qualify for Institute membership.

DISTRICT ACTIVITIES

Auckland:

Mr. D. P. Joseph attended a recent meeting of the Institute Council, and as a result obtained up-to-date information respecting the affairs of the Institute which will be conveyed to Auckland members in due course.

Dunedin:

An address by Mr. E. R. Hodgson was recently delivered to Dunedin members on "Vacuum Tube Voltmeters: How to Make Them and How to Make Them Work."

The lecture was followed with keen interest by all present, and the lecturer, who began with the fundamentals, explained and demonstrated the development of vacuum tube voltmeters to their present type.

The care and attention to detail was appreciated, and at the conclusion of the lecture a hearty vote of thanks was accorded the speaker.

Wellington:

An address by Mr. W. D. Foster, B.Sc., A.M.Brit. I.R.E., M.N.Z.E.I., was delivered to Wellington members in October, entitled "Some Aspects of Modern High-quality Audio Equipment," with a survey of the development and application of negative feedback. Although its advantages had been known for some time, it was not until the Type 6L6 valve was placed on the market that negative feedback was introduced into commercial equipment. Of all the advantages to be gained by its use, the chief one was in the reduction of distortion. The old limit of 5 per cent. harmonic distortion which was, until recently, considered satisfactory, has now been corrected, because it has been proved that the ear can detect amount of distortion. There is difficulty in using large amounts of feedback, unless special precautions are taken, due to phase shift at the high and low frequencies, but modern developments have largely overcome this difficulty. One method is to reduce phase shift to a minimum by use of direct coupling and special phase inverter in the early stages of the amplifier, then apply a large degree of feedback. This is the object of the Williamson amplifier, which has reduced harmonic

distortion to better than 0.1 per cent.

Another school of thought advocates the use of standard circuits but with the amplifier designed so that distortion is reduced to a small degree, after which a minimum of feedback is applied.

Mr. Foster then described a method of detecting distortion with the use of the oscilloscope, which he demonstrated to members at the conclusion of his talk.

The principle of the Scott dynamic noise suppressor was next described, but, through lack of time, Mr. Foster was unable to complete his prepared address.

Mr. Gilby thanked the speaker for his most instructive and interesting address and a hearty vote of thanks was accorded by acclamation.

* * *

The meeting prior to the above address took the form of a visit to D.P.L., Gracefield, to hear a description and to see a demonstration of the electron microscope.

The chairman introduced the lecturer, Mr. K. Williamson, M.Sc., to the meeting, and Mr. Williamson used the optical microscope as a basis for his description of the various sections which make up the electron miscroscope. In a brief historical treatment, the speaker mentioned that Germany saw the first practical microscope in 1932, England in 1936, and Canada in 1938, but it was not until about 1940, when R.C.A. produced the first commercial microscope, that this instrument became of use to science. England could not proceed with her developments due to the intervention of the war, but since then has produced a number of commercial types.

Improvements are brought about at such a rate that even today New Zealand's new electron microscope is already out of date, but that does not detract from its usefulness.

The preparation of the specimen, using a special grid and a film of cellulose nitrate, was demonstrated by Mr. Williamson, who also described a method called "shadowing," which, by splattering gold on to the side of the object, enables science to determine the height of the viewed object.

The demonstration followed, where small groups studied this seven-foot wonder and viewed objects magnified about 20,000 times, while the remainder of the meeting examined samples and photographs which had been very thoughtfully arranged in a room adjoining that used for the demonstration.

Mr. Rushworth paid tribute to the speaker for the able manner in which he dealt with the subject and demonstration, and a hearty vote of thanks was accorded with applause.

The serving of supper concluded a very successful and enjoyable evening.

The *Radio and Electronics* Abstract Service

ANTENNAE AND TRANSMISSION LINES:

Tune Your Antenna With a String. Description of method for remotely tuning antenna to resonant frequency or to any harmonic. Uses 75-ohm twin-conductor, and length of antenna is varied by means of a pulley system. Instruction for construction of a 75-80 metre doublet which will tune satisfactorily on 20 metres also.
—**Radio News (U.S.A.), October, 1949, p. 47.**

Self-supporting Towers for TV Antenna Arrays. Details of construction of two towers, one a ten-foot section and the other twenty feet high. Thinwall conduit employed in construction. Design suitable for supporting arrays for amateur transmitters.
—**Radio News (U.S.A.), October, 1949, p. 57.**

Rhombic Antennae for TV. Characteristics of rhombic antennae. Design dimensions; antenna patterns, feed systems, and general hints of a useful nature.
—**Radio News (U.S.A.), October, 1949, p. 61.**

A Three-pound 10-metre Beam. Constructional details of lightweight all-metal two-element antenna for 10-metre (amateur) band. Metal used is an aluminium alloy. Feed system may be either coaxial cable or 300-ohm line.
—**Radio News (U.S.A.), October, 1949, p. 70.**

The "Gamma" Match. Description of method of feeding home-made "plumber's delight" 3-element beam with coaxial line RG-8/U: a type of coaxial cable obtainable in quantity on U.S. war-surplus market).—**QST (U.S.A.), Sept., 1949, p. 20.**

Vertical Beams on 14 mc. Description of vertical beams, tuning systems, illustrations of antennae patterns, and summary of results achieved by use of vertical systems.
—**QST (U.S.A.), September, 1949, p. 48.**

AUDIO EQUIPMENT AND DESIGN:

Rating Sound System Performance. Principles underlying measurement of characteristics of microphone, amplifier, recorder (including tape recorders), pick-up, and loudspeaker. Standardized procedures suggested for making such measurements.
—**Radio News (U.S.A., Rad. El. Ed.), Oct., 1949, p. 15.**

A Wide-range Equalizing Amplifier. Circuit and construction of a phono equalizer for crystal or magnetic pick-ups, providing bass or treble boost. Uses 7C7 pentode valve and resistor network. Valve 6SJ7, or 57, may replace type 7C7.
—**Radio News (U.S.A.), October, 1949, p. 53.**

Magnetic Recording Technique. Article covers practical aspects of magnetic recording, tape, and wire, and is intended to assist those who wish to experiment with these systems.
—**Wireless World (Eng.), October, 1949, p. 362.**

High-quality Amplifier. The new version of the Williamson amplifier. This article deals with tone controls and auxiliary gramophone circuits.
—**Wireless World (Eng.), October, 1949, p. 365.**

Feed-back Amplifier Design Conditions for Flat Response. Performance of amplifiers treated in whole frequency band from zero to infinity in terms of frequency response. Design of amplifiers with up to four stages of resistance-capacitance or tuned-circuit coupling, with constant feedback and equal centre-frequency for all stages. Design formulae given for determining characteristics and component part values for amplifiers with definite pre-selected frequency response.
—**Wireless Engineer (Eng.), September, 1949, p. 297.**

Audio Frequency Measurements: Part 1. Measuring procedures fully described. Reproduction of a paper presented at joint IRE-RMA (U.S.) meeting.
—**Audio Engineering (U.S.A.), October, 1949, p. 13.**

Continuously Variable Loudness Control. Constructional details of a simple control unit with maximum control range of 30 db., which range has proved to be adequate.
—**Audio Engineering (U.S.A.), October, 1949, p. 17.**

Simplified Circuit for Audio Image Rejection. Circuit and construction of a unit for use with amateurs' receivers. Audio phasing principles are applied to CW beat-note reception. Audio filtering gives results claimed to be equivalent to those obtained with crystal-filter in communications receivers.
—**QST (U.S.A.), September, 1949, p. 13.**

Vented Loudspeaker Cabinets. Design of vented cabinets. Basic formula for calculating the required dimensions.
—**Wireless World (Eng.), October, 1949, p. 398.**

CIRCUITS AND CIRCUIT ELEMENTS:

Complete Circuits for H.F. Heating. Design and function of coupling circuit between H.F. generator and associated H.F. circuit, including load to be heated. Various practical methods of coupling illustrated.
—**Radio News (U.S.A., Rad. El. Ed.), October, 1949, p. 9.**

Mains-Battery Turntable. Circuit of a unit suitable for mobile public address work. Apparatus consists of non-synchronous vibrator, vibrator transformer with centre-tapped primary, and some small condensers. Sparking substantially reduced by use of condenser in series with turntable motor to present resistive or capacitive load to vibrator instead of an inductive load which would tend to produce sparking.
—**Wireless World (Eng.), October, 1949, p. 375.**

Electronic Circuitry. (1) Direct current stabilizers; (2) neutralizing phase-splitters.
—**Wireless World (Eng.), October, 1949, p. 395.**

The Design and Limitations of D.C. Amplifiers: Part 2. Continuation of discussion of design points in D.C. amplifier work. Circuits given include cathode-follower input stage for low input capacitance; pentode used as cathode load; circuit for compensating for variations in heater current; use of gas discharge tube to couple stages without loss of gain; use of pentode to provide high impedance for coupling network. Consideration given to use of negative feedback for stabilization.
—**Electronic Engineering (Eng.), October, 1949, p. 355.**

Constant Phase Shift Networks. Simplification of design by first designing attenuation network corresponding to phase-shift network, and from its parameters those of phase-shift network are calculated. Design procedure given.
—**Wireless Engineer (Eng.), September, 1949, p. 283.**

MATERIALS AND SUBSIDIARY TECHNIQUES:

"Araldite." Description of a new plastic material claimed to have excellent electrical and mechanical properties. New material has several advantages over existing materials; it does not give off water or volatile products when it sets; it has little shrinkage when it hardens; and it has remarkable adhesive properties.
—**Electronic Engineering (Eng.), October, 1949, p. 389.**

MATHEMATICS:

Elementary Binary Mathematics. An explanation of the Binary system, with special reference to employment in work with electronic computers.
—**Radio News (U.S.A., Rad. El. Ed.), October, 1949, p. 7.**

Template for Vector Diagrams. A useful template described by use of which increased speed and accuracy possible in drawing vector diagrams. May be made of celluloid or perspex.
—**Electronic Engineering (Eng.), October, 1949, p. 392.**

MEASUREMENTS AND TEST GEAR:

Novel Tubeless Tone Generator. Circuit and description of a simple frequency-multiplier type of tone generator. Full-wave rectifiers (using crystal diodes, 1N34 type) are cascaded, and transformer coupling is used between stages. Circuit given for a code practice oscillator employing this principle; 2.5v. midget

filament transformer used in first stage. Coupling to further stage by microphone transformer. Four 1N34 diodes required.
—Radio News (U.S.A.), October, 1949, p. 39.

Electrical Telemetering. Article describes equipment and summarizes techniques employed in telemetering. Simpler to more complex equipment described.
—Radio News (U.S.A., Rad. El. Ed.), October, 1949, p. 3.

A Signal Tracer at Minimum Cost. Circuit and construction of a simple signal tracer of which the basis is a conventional three-stage audio amplifier. Details of special test-prod which employs 1N34 type crystal diode.
—Radio News (U.S.A.), October, 1949, p. 49.

Audio Service and Development Techniques. Test equipment and techniques for audio servicing. Description of development chassis constructed for experimentation with new and improved circuits.—Radio News (U.S.A.), October, 1949, p. 72.

A Wide-band Scope Amplifier. Circuit of three-step frequency compensated attenuator, a cathode-follower input stage coupled to a grounded-grid amplifier, compensated for high-frequency response. Grounded-grid stage is direct-coupled through constant impedance network to p.p. cathode-coupled deflection amplifier, which, in turn, connects directly to one set of deflection plates. Identical units for vertical and horizontal sweep. Deflection sensitivity is approximately 21 r.m.s. volts-per-inch at the plates, or approximately .07 r.m.s. volts-per-inch through the amplifier. Frequency response is relatively flat from 0 cycles to approximately 1 megacycle. Each deflection circuit uses 6SN7, 6V6, 6V6 stages. Details are given of an alternative, eleven-step attenuator.
—Radio News (U.S.A.), October, 1949, p. 75.

Reflex Valve Voltmeter. Circuit and design of simple, one-valve V.T.V.M. employing reflex, or automatic slide-back, system, effectively stabilised. Circuit given is for meter having ranges 5, 20, and 50 volts.
—Wireless World (Eng.), October, 1949, p. 401.

MICROWAVE TECHNIQUES:

Microwave Lenses. A general survey of the three main types: (1) metal plate, (2) artificial-dielectric, and (3) path length.
—Wireless World (Eng.), October, 1949, p. 370.

PROPAGATION:

Some Aids in Sketching Field Strength Diagrams. Useful hints for preparation of polar diagrams. Equations and geometrical constructions. Illustration, for comparative purposes, of field strength diagrams for two radiators, two wavelengths apart, calculated (1) by hyperbolic method demonstrated, and (2) by usual approximations.
—Electronic Engineering (Eng.), October, 1949, p. 375.

Electrical Properties of Water. Reflection characteristics of water surfaces at V.H.F. Discussion on variation of dielectric properties of water as a result of anomalous dispersion.
—Wireless Engineer (Eng.), September, 1949, p. 288.

RECEPTION AND RECEIVERS:

A Low-cost Ham Receiver. Circuit and construction of a receiver for amateur bands to 28 mc.; 6AC7 mixer (no R.F. stage); 6C5 oscillator; 6SG7 first I.F. (regenerative); 6SF7 second I.F. and second detector, 6SL7GT first audio-beat oscillator, 6V6 output. Voltage stabilized power supply. No A.V.C. Intermediate frequency is 1600 kc. Plug-in coils (iron core).
Radio News (U.S.A.), October, 1949, p. 54.

TELEVISION:

Basic Equipment for Small TV Station. Description of minimum amount of equipment for operation under interim conditions.
—Radio News (U.S.A., Rad. El. Ed.), October, 1949, p. 12.

Fringe Area TV Reception. Reception of TV signals in areas where average signal strength is of order of only 5 microvolts per meter. Discussion of factors governing reception in such areas. Importance of proper antenna and booster design. Details of a folded-dipole antenna with good back-to-front ratio and high gain.—Radio News (U.S.A.), October, 1949, p. 44.

Modern TV Receivers: Part 19. Horizontal sweep systems for magnetic deflection tubes. Operation, and differences between such systems and those used with electrostatic tubes.
—Radio News (U.S.A.), October, 1949, p. 58.

A Projection System for Domestic TV Receivers. Description of a projection TV system developed by an English manufacturer and suitable for use with existing TV receivers. Equipment comprises three units: (1) 2½-inch picture tube, 2) optical unit, and (3) compact E.H.T. supply. Adequate picture resolution obtained up to 15 inches by 12 inches.
—Electronic Engineering (Eng.), September, 1949, p. 314.

TRANSMITTERS AND TRANSMITTING:

450 Watts on V.H.F. Circuit and construction of a high-powered transmitter for operation on 50 and 144 mc. amateur bands. Tetrode valves employed throughout. Exciter has separate output stages for the two bands. 6AR5 tritet crystal

(Concluded on page 48.)

NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

COURTENAY MODEL 19 "AJAX" TURNBULL & JONES, LTD.

Designed to fill a popular demand this set is a five-valve broadcast radiogram equipped with 6 in. speaker, low-mass lightweight permanent sapphire stylus needle, rim-drive motor, and automatic stop and start.

The receiver is very sensitive and is equipped with A.C. switch and Miller effect tone control.

The valve line up is 6K8-GT, R.F. amplifier; 6U7G, I.F. amplifier; 6Q7-GT, diode detector/A.V.C./audio amplifier; 6K6-GT, power output; 6X5-GT, rectifier. Radiogram switch is included and use is made of a special pick-up coupling transformer giving correct matching for the pick-up into the amplifier grid. The gramophone performance is specially pleasing. The set is housed in a most attractive walnut cabinet with high gloss finish.

This is a most attractive model at a competitive price and there is no doubt that a ready sale will be found for it.

* * *

NEW HIGH-GAIN CONVERTER VALVE RADIOTRON TYPE X61M

The X61M is a frequency changer of the triode hexode type, having a high conversion conductance and a comparatively low cathode current, giving a good signal-to-noise ratio. It is suitable for operation up to a frequency of 60 megacycles per second.

The triode hexode has been recognized as possessing advantages over other frequency changer valves, especially when operation is required at the high frequencies. The X61M has the following advantages over other triode hexodes:—

(1) High conversion conductance for comparatively low cathode current.

(2) Low wattage heater.

(3) Large control ratio when operated with a fairly constant screen voltage.

Good stocks of the X61M are held at all branches of the sole New Zealand distributors, the National Electrical and Engineering Co., Ltd.

ROLA "ANISOTROPIC" SPEAKERS ARE GUARANTEED FOR 12 MONTHS FROM DATE OF MANUFACTURE.

TRADE WINDS

Latest addition to the ranks of radio manufacturers is Electro-Technical Industries, Ltd., Wellington, a recently formed company at the head of which are Ralph Wiseman and Dave Heinemann. This organization will specialize in the assembly of wafer-type rotary switches.

Having served with the Imperial Army in the Middle East and in Germany during the last war, Ralph Wiseman, formerly of A. J. Balcombe, Ltd., England, decided on a complete change of location. On arriving in New Zealand 17 months ago, he joined the staff of Collier & Beale, Ltd., later transferring to Electronic and General Industries as factory manager.

After demobilization, Dave Heinemann, an ex-R.N.Z.A.F. radar mechanic, whose experience extends from New Zealand and the Solomons to Great Britain with the R.A.F. and R.N. during the war, elected to continue his science studies at Victoria University College, after which he spent three years on the road gaining valuable experience as a commercial traveller.

Through these pages, "Radio and Electronics" conveys our best wishes to these ambitious young men for every success in their future undertakings.

Publications recently received by "Radio and Electronics" include—

"Westinghouse Engineer," July, 1949, from H. W. Clarke, Ltd.

A 27-page Brimar Valves Handbook covering Mains Miniature range for 1949, from Standard Telephones and Cables, Ltd., Wellington.

Also from Standard Telephones and Cables, Ltd., Wellington, Catalogue B/MB1 on Permalloy and Perendor magnetic materials, describing physical properties and general magnetic characteristics by tables and graphs.

From Electric Lamphouse, Ltd., the "Lamphouse Annual for 1949-50." This is an anniversary issue commemorating 20 years of service, and its 130 pages are a fount of Lamphouse information.

From the National Electrical and Engineering Co., Ltd., Mazda (BTH) Bulletin L844, describing Type F.A.1 and F.A.2, Mazda flash discharge tubes for photographic and stroboscopic applications.

(Continued on page 48.)

PHILIPS Experimenter

(Continued from page 25.)

circuit. In the power supply circuit given last month, we showed the relay in parallel with a resistor, and this is the basic arrangement for cases where the relay has a higher resistance than 6000 ohms. Now, whatever the arrangement used, whether series or parallel, two conditions will have to be satisfied. First, the combination of resistor and relay will have to total 6000 ohms, so as to present the correct grid leak value, and secondly, the relay must come into operation at the selected value of grid current. Because constructors will not in general be able to use similar relays to the one in the original, we have not specified the exact arrangement of resistors with the relay, and this will have to be worked out by the individual builder. In the first place, it is obvious that any relay to be used in this position must operate on 8ma. or less. If it works at a current close to the 8ma., the relay clearly must have a resistance equal to or less than 6000 ohms, otherwise, when resistance is placed in parallel with the coil in order to make the combination equal to 6000 ohms, insufficient current will flow through the relay to operate it. If the operating current is not much less than 8ma., and the resistance is less than 6000 ohms, then a simple series circuit will fill the bill. However, if the relay is designed to work at much less than 8ma., it might overheat if the whole 12ma. of grid current is allowed to pass through it. Also, it would operate at a grid current that is too low for safety, and the protective action would be lost. In that case, it will be necessary to put resistance in parallel with the relay until a current of 8ma., through combination causes the relay to come in. In this case, however, it is highly likely that the resistance of the relay and resistor in parallel will be less than 6000 ohms. It will then be necessary to add resistance in series until the total is 6000 ohms. This was the case with our 100,000-ohm relay, which finished up with 10,000 ohms in parallel with it and 1,000 ohms in series with the pair.

THE CATHODE RELAY

No difficulty attaches to the relay Rl_3, in the cathode circuit of the final. This is a ZC1 keying relay, and required no modification. Its resistance is 150 ohms, with the result that it gives a small amount of cathode bias to the final amplifier. This is not enough to give full protection in the event of excitation failure, but the grid circuit relay looks after this in any case. All that has to be done with the cathode relay is to adjust it so that it pulls in at a current of approximately 100 ma., and that when the final amplifier plate current is reduced, the relay releases at not less than 50 ma. This means that when the final is loaded up, the relay comes in and turns on the H.T. supplies to the modulator. Also, should anything untoward happen in the aerial circuit, so that the proper load for the final is no longer presented, the relay will release before the load presented to the modulation transformer is so small that there is a danger of the transformer's flashing over.

For those not well versed in the ways of relays, we may mention that the spring tension governs the current at which the relay will pull in, while the current at which it releases is determined largely by the distance at which the armature is held from the magnet pole in the operated position. Of course, the position of the stop which holds the armature in the released position also helps to determine the current at which

the relay operates. The essential points are these, however: To increase the drop-out current, the stop is adjusted so that the armature is held farther from the pole-piece after it has operated. This will hardly affect the pull-in current, which can be decreased by screwing the upper stop so that the armature has not so far to move in operating. Should this have to be carried to the point where the spacing between the two stops is insufficient to prevent arcing on the break, then it can be remedied by slacking off the tension of the spring and increasing the distance of travel once more to restore the original pull-in current.

GRID BIAS SUPPLY, AND VOLTMETER CIRCUITS

In the power supply diagram given last month, we purposely left off two portions of the complete circuit. These were the grid-bias supply for the modulators, and the circuit used to give measurement of all supply voltages in the power supply unit. These would have necessitated too large a diagram, and so they have been drawn separately, and are presented here.

Fig. 1 shows the bias supply circuit, which is attached to the exciter's power transformer. There is reason in this choice, for it will be remembered that this is the first H.T. transformer to come on, as governed by the interlocking system. Thus, the bias for the modulators must be present by the time the modulators' plate and screen supplies come on, and there will be no danger of the modulators being turned on without any bias. A simple shunt rectifier system is used, and since only a very small bleed is needed, resistance-capacity filtering is successfully used. However, the proof of the pudding is in the eating, and reports have shown that the carrier is devoid of hum, whether or not the modulators are on. A 100k. potentiometer is used as a bias adjuster, and this was mounted on the back of the power supply chassis, as a pre-set control. In the figure, only the parts outside the dotted line belong to the bias supply itself. The rectifier is an EZ35, with sections connected in parallel.

The metering circuit uses a 0–0ma. meter, some carbon resistors, and a two-pole five-position switch to measure the voltages of all five supplies, including the modulator grid bias. The arrangement is a trifle unusual, because proviison had to be made, not only to reverse the meter leads for the grid bias measurement, but also to connect the same multiplier resistor as is used on this range permanently across the bias supply when the meter is on one of the other ranges. This prevents the actual bias from altering, as it would if the meter were removed without keeping the 100k. shunt across the supply. In the chassis diagram given last month there was provision for the meter on the front panel. However, no provision was shown for the meter switch. This is placed directly under the meter, but as close as possible, so that it will not foul the top of one of the smoothing chokes, which occupies a spot just under the meter, at the front of the chassis. Unfortunately, we have taken up so much space describing the operation of the relay circuits that we have no room to print the promised photos of the finished power supply panel and chassis. However, space will be found for this later. A further panel is to be added to the transmitter, containing an all-band aerial coupling unit. This really finishes the whole thing off, in such a way that it will be possible to attach it to any sort of aerial at all. When we can have a rack made for the transmitter, we intend also to print a photo or photos of it complete in all details.

A PRACTICAL BEGINNERS' COURSE

PART 38: A TWO-VALVE BATTERY SET FOR WORKING A LOUDSPEAKER

We have not yet attempted a set which could really be built for someone else to use, since most of our circuits have been in the nature of experimental ones. However, we have made a start on metal-chassis construction, which is one good step towards the building of more advanced sets. This last one, though, was a shortwave set only, and used home-made coils. At this stage, therefore, it is appropriate if we make our next set a broadcast one, using standard commercial coils and a fully-tuned R.F. amplifier stage. Such a set will be a considerable advance on anything we have yet attempted in that it will not be just an experimenter's set when it is finished, but can be given to any unskilled person to use, just as if it were a set bought from a manufacturer. In building it, we will meet some new practices which will take us farther along the road towards full-scale superheterodynes and other things that are meat and drink to the experienced constructor. In particular, this set gives us our first experience of "ganging" circuits together, as is always done in manufactured sets, however small.

PURPOSE OF THIS SET

The set has been designed specially for those who want a small, inexpensive battery set capable of working a speaker and of picking up the local broadcast stations on a reasonably short aerial. Its power output is low, so that it cannot make a great deal of noise, but it can give quite enough driving power to a small speaker for all practical purposes. It uses only two valves, but has a circuit that would need four valves if multi-purpose valves were not available.

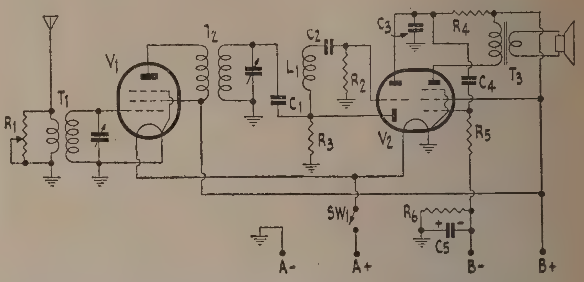
The first valve is a 1N5-GT, used as a tuned R.F. amplifier. The remaining valve is a 1D8-GT, which is really three valves in one envelope. This tube makes it possible to have a four-valve circuit with only two actual valves. It contains a diode, used here as the detector, a triode, used here as a resistance-coupled audio amplifier, and a power pentode, used to drive the speaker. The A battery required is 1.4 volts, and has to supply 150 ma. for the valve filament, while the B battery is 90 volts, and supplies approximately 8 ma., most of which is drawn by the second audio amplifier, or power amplifier. The set is built on a small metal chassis, and photographs of it will be shown in next month's instalment of the course, together with a drawing from which the chassis can be made.

The circuit of the R.F. amplifier is very simple indeed, since it contains only the aerial coil, the valve, and the R.F. plate coil, in addition to the two tuning condensers. The coils, which are commonly known as Aerial and R.F. coils respectively, are commercially made ones, and are much smaller than home-made ones can ever be. They are machine-wound on ½ in. diameter formers, and each winding consists of many turns of very fine stranded wire. To make the coils easier to use, solder lugs are fixed to the former, and, because there are two windings, there are four lugs in all. These lugs are always colour-coded so that the builder shall know which lug should go to which part of the circuit. The colour-code is a standard one, and goes as follows:—

(1) The lugs for the tuned winding (the one which has the tuning condenser connected across it) are coloured green and black. Of these, the green one should be used to connect to the grid of the valve, and the black one goes to earth.

(2) The primary windings have lugs coloured red and yellow. The red lug connects to the H.T. line in the case of the R.F. coil and to earth in the case of the aerial coil. The yellow lug goes to the plate of the valve, in the R.F. coil, and to the aerial in the case of the aerial coil.

As long as this colour code is used, as intended, all will be well, but the coils will not work properly if



Circuit of the set. Values and photographs of the completed set will be given in the next instalment.

the windings are reversed, or if the wrong winding is used as the tuned one.

THE "GANGING" OF CONDENSERS

Ever since sets have been made with R.F. amplifiers, a major nuisance has been that we have two tuned circuits to adjust every time the set is tuned in to a station. In the early days of radio, each tuning condenser was brought out to the panel of the set, and tuning in a station was a matter of adjusting the condensers separately. This took skill, because unless both the tuned circuits are somewhere near the same frequency, no signals at all will be received, so that in searching the dials for a new station, both dials had to be manipulated at once. The first advance on this cumbersome system was to link up the two variable condensers by mechanical means, so that the one dial drove both of them. At the time of which we are speaking, it was not possible to make the tuned circuits identical electrically, so that, although the coupled condensers gave somewhere near the right answer, it was necessary to add a third small condenser in parallel with one of the main ones, and each time a station was tuned in, it was necessary to adjust this trimming condenser, as it was called, for best results. So real single-dial tuning was still not a reality, and tuning a set, though easier, was still dependent to some extent on the skill of the operator.

After a time, however, better manufacturing processes enabled variable condensers to be made much more accurately—so accurately, in fact, that it was a simple matter to make two condensers as a unit, with the rotors mounted on the same shaft and the stators side by side. The one knob turns the two condensers at once, and at all positions of the dial the capacities are accurately matched. Such a bank of condensers is known today as a "gang-condenser," and can be obtained in two-gang, three-gang, and even more. A three-gang condenser, of course, is one with three identical condensers worked by the same shaft. These condensers always have metal frames,

and the only insulation consists of small pieces of porcelain, or other ceramic, which are used to mount the fixed plates to the metal frame.

This set uses a midget two-gang condenser. One section tunes the grid winding of the aerial coil, and the other, the tuned winding of the R.F. coil, which is connected to the diode detector.

Unfortunately, it is not possible to match the whole of a tuned circuit as well as the sections of a gang-condenser are matched. The reason is that, when a set is wired up, some of the capacity in the tuned circuit gets there unintentionally, because the wiring which goes between the coil and the condenser has a small amount of capacity to earth. Also, the grid and cathode of a valve act as a minute condenser, and each valve type has a different grid-cathode capacity, as it is called. Valve sockets, also, introduce small amounts of unwanted capacity into the circuit, and we have no guarantee that the socket capacities will be identical. All these effects are small by themselves but add up to a considerable amount. For instance, unless very special precautions are taken, it is not possible to reduce the capacity in a tuned circuit below a certain minimum, which may be as high as 10 or 15 $\mu\mu$f. This is of the same order as the capacity of each gang-condenser section when the plates are fully out of mesh, with the result that if all these "stray" capacities, as they are called, are not exactly the same for both tuned circuits, we will find that at the high-frequency end of the dial the circuits do not tune to the same frequency, even though the gang-condenser sections are perfectly matched.

All this sounds pretty hopeless, but theer is a very simple means by which the effects of the stray capacities can be made identical, thereby restoring the tracking of the two tuned circuits. By tracking is meant the manner in which the frequencies of the tuned circuits are made identical at all dial settings. If this condition does not hold, the circuits are said to be out of track, or out of line.

SIMPLE STROBOSCOPE

(Continued from page 33.)

It should be emphasized, however, that the circuit described cannot be described as a precision tachometer, because, if great accuracy is required, special precautions have to be taken to ensure that the lamp frequency is not varied by changes in line voltage and by changes in tubes. The difficulty is that to find speed to an accuracy of 1 per cent. does not give a figure that is very close in terms of r.p.m. For instance, 1 c/sec. error in the multivibrator frequency represents 60 r.p.m. error, even though the percentage error is still 1 per cent. Thus, for precision work, much more care is necessary in the design of the circuitry than we have put into this simple instrument. However, for visual observation and for a quick check on r.p.m., the simple instrument we have described will fulfil a host of requirements. Also, if one has an accurate audio oscillator, it is a simple matter, if a really accurate answer is wanted, to do a spot calibration in the manner described above.

1950 PORTABLE

(Continued from page 26.)

found that the trimmer peaks in the same place at both 1400 and 600 kc/sec., indicating that the loop inductance is correct. When this has been carried out, it will be very noticeable that the sensitivity is high all over the broadcast band, while before the inductance was corrected, the sensitivity dropped off quite badly at the low-frequency end of the dial, even though the trimmer was correctly adjusted at the high end. Careful adjustment in this way makes all the difference to the performance of a portable, and when it is done with a set like this one, which uses a rather more sensitive mixer valve than usual, the results will be quite startling.

As mentioned above, the performance of the prototype was outstanding, and it was possible not just to hear 3YA in Wellington during the day, but to really use it for entertainment because of the low noise-level. This is achieved simply because of ample sensitivity and excellent alignment. A little care taken over the latter and the builder will have a portable receiver that will astonish everyone, and will perform at least as well as the best commercial sets.

N.Z. RADIO TRADERS' FEDERATION

(Continued from page 29.)

Government Departments concerned for their confidence in the radio industry and the trust which has been vested in the industry.

Your Executive confidently looks forward to the future, in the knowledge that each and every member of our associations will carry the responsibility with credit both to himself and to the trade as a whole.

Yours faithfully,

G. J. MARKBY, President.

ABSTRACT SERVICE

(Continued from page 42.)

oscillator (crystals either 8 mc. or 6 mc.), 6AR5 doubler, 832A amplifier or tripler, and 832A final amplifier. Transmitter will operate well at any power level from 100-500 watts.

—QST (U.S.A.), September, 1949, p. 22.

A 1950 V.F.O. Exciter. Useful ideas for incorporation in V.F.O. design; 15 to 20 watts output on all bands from 3.5 to 28 mc. are obtained from unit described. Clapp oscillator circuit used. The unit described is rather more elaborate than usual. Has 6AC7 oscillator, 6AC7 and 6AG7 buffer stages, respectively, and 2E26 amplifier; 6SN7 valve is used for control purposes as part of keying system.

—QST (U.S.A.), September, 1949, p. 29.

MISCELLANEOUS:

A Simple Electronic Musical Instrument—the Theremin. Circuit and construction of an instrument, the sound of which the article reports as "hard to describe." Tuned with both hands; one hand varies frequency and the other hand controls the volume.

—Radio News (U.S.A.), October, 1949, p. 66.

A Time-sharing System of Multiplex. Description of practical systems in use. Multiplex telephony and pulse-time modulation explained. Transmitter and receiver waveforms at various stages are illustrated, also channel equipment.

—Electronic Engineering (Eng.), October, 1949, p. 360.

The Analysis and Synthesis of Musical Sounds. An interesting and full discussion on subject of sound analysis and synthesis. Reference to an acoustical harmonic and synthesizing unit, its construction and operation.

—Electronic Engineering (Eng.), October, 1949, p. 379.

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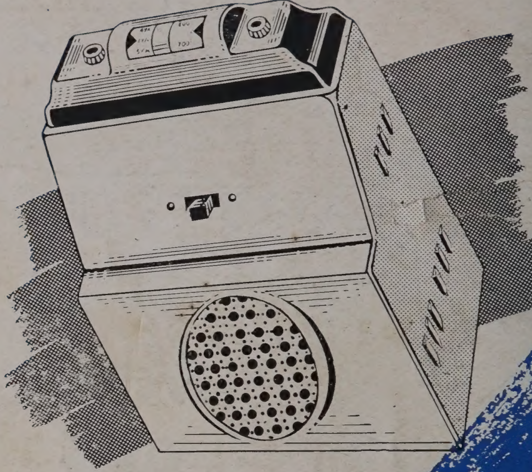

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